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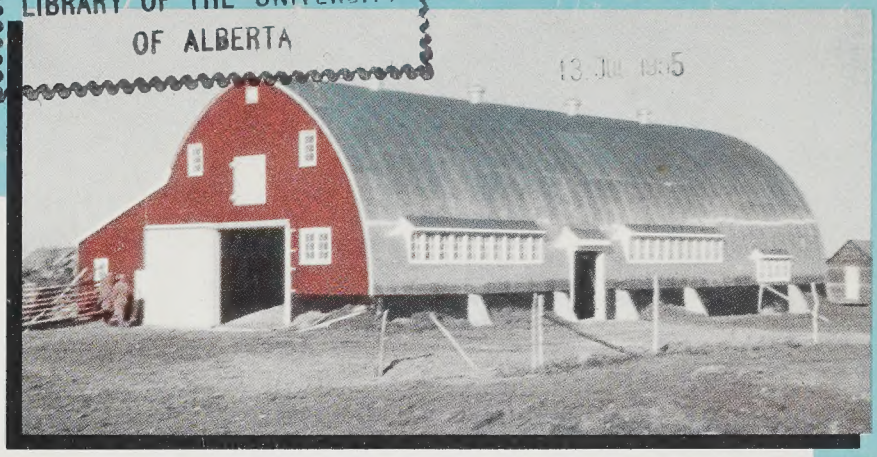

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DAIRY BARNS for Alberta

GENERAL SCIENCES

ONE WEEK LOAN

Joint Series
Publication No. 7

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PROVINCE OF ALBERTA
Department of Agriculture

UNIVERSITY OF ALBERTA
Faculty of Agriculture

DAIRY BARNS FOR ALBERTA

by

F. V. MacHARDY, C. A. CHESHIRE, R. P. DIXON

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Authors' Note

In this guide to dairy barn construction the plans are not intended as detailed drawings. It is hoped, however, that they will help in planning the layout and style that will best meet the needs of the reader.

Stall-type barns have been used on the Prairies for many years. Those illustrated contain the best features based on long experience.

Loose-housing barns are new to this area. Better types will no doubt be developed as time goes on. Farmers have long been known for their ingenuity and there is plenty of scope in this new system for original ideas. Plans of loose-housing units in this bulletin are typical of those best serving our purpose in this province today.

DAIRY BARNS
FOR ALBERTA

by

F. V. MacHARDY[1], C. A. CHESHIRE[2], R. P. DIXON[3]

PLANNING THE BARN

A WELL planned barn gives the service for which it was built. It saves time and labour, maintains comfort and health of animals and workers, and ensures satisfactory conditions for production of milk and cream.

The size of the barn will depend on the extent of the business — both present and future. The extent of the business will depend on the size of the farm and the amount of feed and pasture it can produce.

In choosing the location several things must be kept in mind. The barn should be built about 150 feet from the house and so placed that prevailing winds will carry odours away from the house. A shelterbelt on the north and west sides of the farmstead will protect live stock in adjacent yards and provide a snow-trap in winter. Farm buildings should be far enough apart that fire which may start in one will not endanger the others.

Selection of a high, well-drained site for the barn is important. If the site is not naturally drained, it should be graded up. A paved barnyard will save labour in cleaning the cows, and add greatly to the convenience of handling the stock.

The farm barn should be located near a plentiful supply of water and provide easy access by lanes to pastures and hay fields. Since live stock need large amounts of roughage and concentrate in winter, convenient storage in or near the barn will save labour.

Permanence, sanitation, and attractiveness must all be considered. An attractive barn and its surroundings adds to the value of the farm and is a source of satisfaction to the owner. Since the farm barn represents a large investment, only materials that make for a permanent structure should be used. By following the best building practices you will save on upkeep.

Firm footings, wood parts away from moisture, ample bracing in the frame, sills anchored against wind damage, and durable roof and sidewalls are a good investment. A well planned barn, properly constructed, will aid materially in having clean livestock in clean surroundings.

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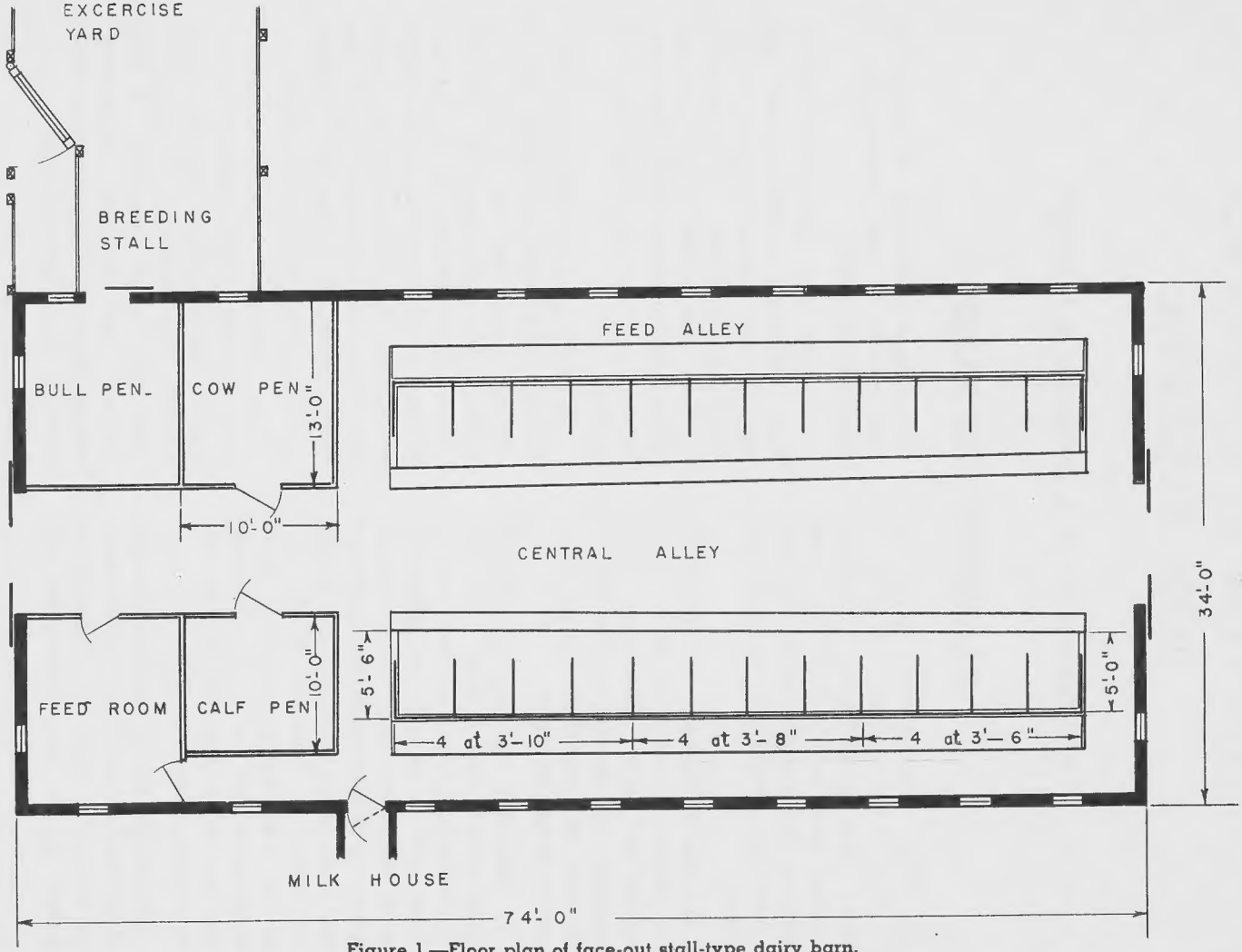


Figure 1.—Floor plan of face-out stall-type dairy barn.

STALL-TYPE DAIRY BARNS

IT'S not easy to draw up a set of plans that will suit all conditions. The breed of milk cow, size of the herd, and number of young stock to be kept in the barn will all influence its size.

FLOOR PLAN

To find the desired barn width, add together the widths of the alleyways, mangers and gutters and the length of the stalls. If a double row of stalls is used, a width of less than 34 feet will not usually allow alley and driveway space.

The length of the barn will depend on the number of cow stalls and the space desired for feed-room and bins. A bull and young stock kept in the barn will add to its size and cost, but convenience in handling will partially offset the added cost. For larger dairy herds a double row of stalls with the cows facing out from a central driveway is generally favoured by operators.

Face-Out Stalls

The face-out stall arrangement in Figure 1 is the most popular. It has the advantage of a wide centre driveway and makes barn cleaning easier. In this plan stalls for 24 head are shown, and the stalls are graduated in size to better accommodate large and smaller animals. Both rows of stalls may be graduated as shown or one row may have stalls of uniform length. A breeding stall next to the barn is very convenient and makes for safer handling of the dairy bull.

Face-In Stalls

Some dairymen prefer face-in stalls with centre feed alley and side litter alleys (Figure 2). The shorter feeding route is of special advantage if outside or end feed storage is used, but barn cleaning is more difficult. The alleys are not wide enough to drive through with a manure spreader, but this problem can be met with a litter carrier. Like the face-in arrangement both rows of stalls may be graduated, or one row may contain stalls of uniform length.

Stalls and Mangers

Figures 3 and 4 show the common dimensions of stalls for two-row barns. Figure 3 shows the face-out stalls and Figure 4 the face-in stalls. In each case the sweep-in manger is shown on the left and the high manger on the right.

Low mangers are the simplest to construct and they save labour in feeding and cleaning. One criticism of this type of manger is that the cows injure their knees while reaching for feed in the alley. Dimensions for low mangers are shown in Figures 3 and 4. Dimensions for high mangers, which vary with the height, are shown in Table I.

Alleys

Feed alleys in a face-out arrangement should be from 3 feet to 4 feet wide exclusive of mangers. In the face-in type they should be 4 to 6 feet wide. Where high mangers are used, the wider feed alleys are more desirable.

Litter alleys in face-out barns should be 7 feet 6 inches to 9 feet wide exclusive of gutters. Where the cows face in these alleys should be 5 to 6 feet wide.

Cross alleys should not be less than 3 feet 6 inches wide where feed trucks are used. To find the width needed for turning an ordinary feed truck, subtract the width of feed alley from 8 feet 4 inches; the remainder is the width of the cross alley. Curving the end of the manger or using a short truck will permit the use of narrower cross alleys.

Gutters

The most satisfactory width of gutter is 16 inches. Sides and bottoms should be trowelled smooth for easy cleaning and upper corners should be rounded slightly. Vertical sides on the gutter will lessen the amount of splattering. The gutters should be sloped ½ inch per ten feet, and should be provided with drains.

A depth of 7 inches on the stall platform side and 5 inches on the cattle walk side is the most satisfactory depth for the gutters.

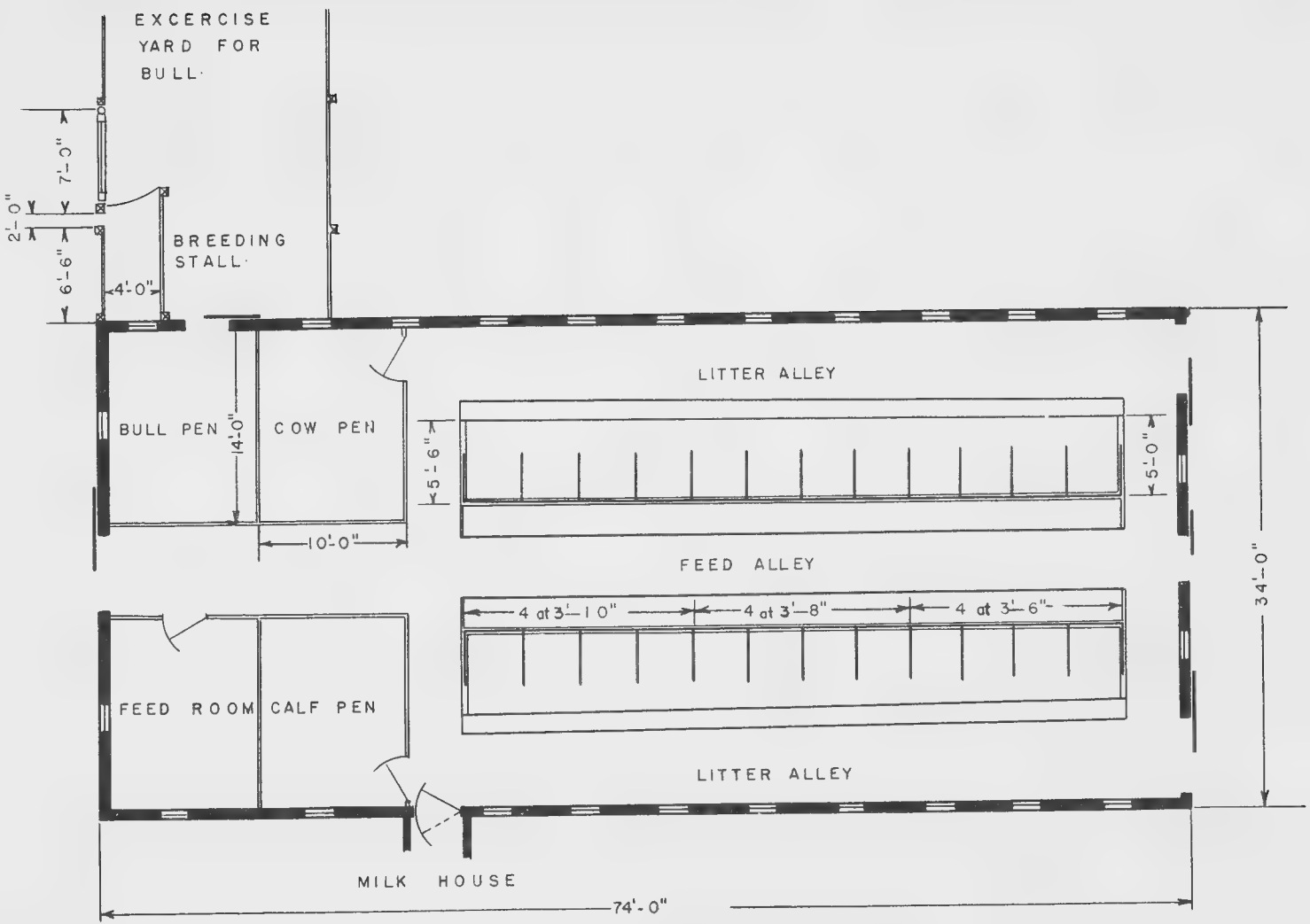


Figure 2.—Floor plan of face-in stall-type dairy barn.

TABLE I.

High Manger Dimensions

C (width) ----	32"	30"	28"	26"	24"	22"
D (height)------	26½"	23½"	20½"	17½"	14½"	11½"

NOTE :—Mangers more than 28 inches wide cannot be used in a 34-foot barn without reducing the alleyways and driveway below desirable widths.

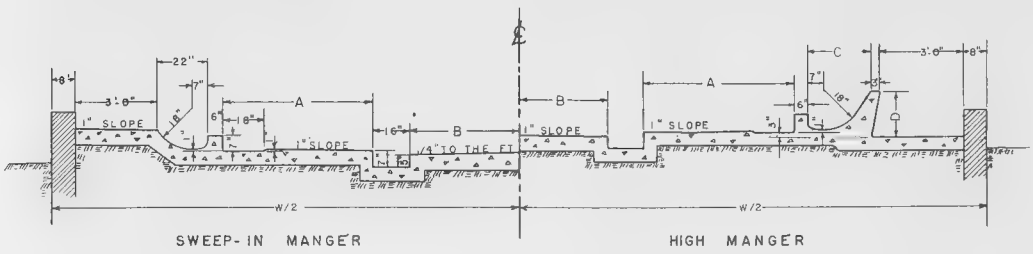


Figure 3.—Floor section of face-out stalls.

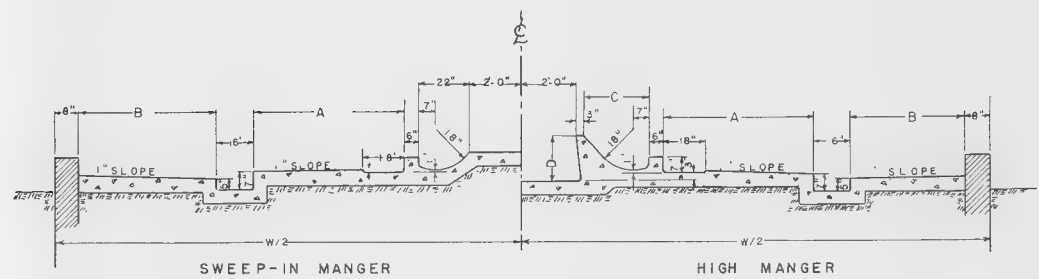


Figure 4.—Floor section of face-in stalls.

Table 2 shows the length and width of stalls for various breeds and sizes of cows.

TABLE II.

Length and Width of Stalls.

Breed	Width	Length of Platform*		
		Small	Medium	Large
Holstein----------	3′ 6″ to 4′ 0″	4′ —10″	5′ — 2″	5′ — 8″
Shorthorn----------	3′ 6″ to 4′ 0″	4′ — 8″	5′ — 0″	5′ — 6″
Ayrshire----------	3′ 6″ to 3′ 8″	4′ — 6″	5′ — 0″	5′ — 6″
Guernsey----------	3′ 4″ to 3′ 6″	4′ — 6″	4′ —10″	5′ — 4″
Jersey----------	3′ 4″ to 3′ 6″	4′ — 4″	4′ — 8″	5′ — 0″
Heifer (any breed) ---	2′ 9″ to 3′ 2″	3′ — 8″	3′ —10″	4′ — 2″

* Shown as A in Figures 3 and 4.

Pens

Size of pens are determined by the size of the animals. If only one or two pens are provided they should be approximately 12 feet x 12 feet.

For several calves in one pen allow a minimum area of 20 square feet for each calf.

Construct pens so they can be easily cleaned and disinfected, provide solid curbs 6 inches high between pens and at alleys, and drain washings from pen through a hole in the alley curb. Locate the gate and manger in a maternity pen so that the attendant enters the pen on the right hand side of the cow when she is at the manger.

Size and Height for Special Pens

Type of Pen	Size in Feet	Height	
		Feet	Inches
Bull ------	12x12 to 12x16	5	3
Maternity-	9x10 to 12x12	4	6
Calf ----	4x 6 to 12x12	3	9

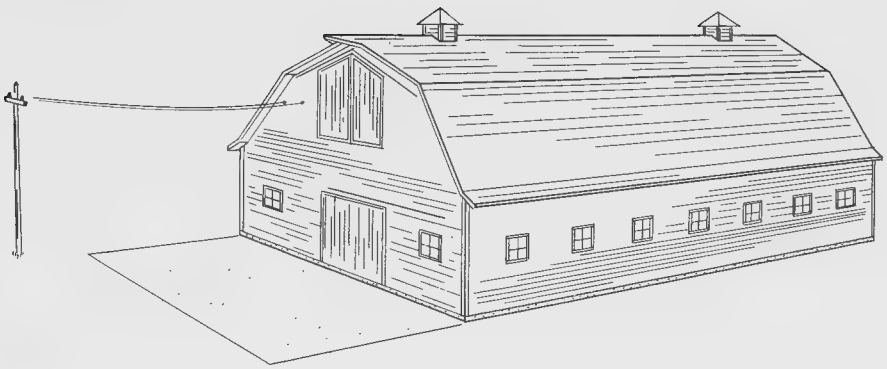


Figure 5.—Perspective view of gambrel-roofed barn.

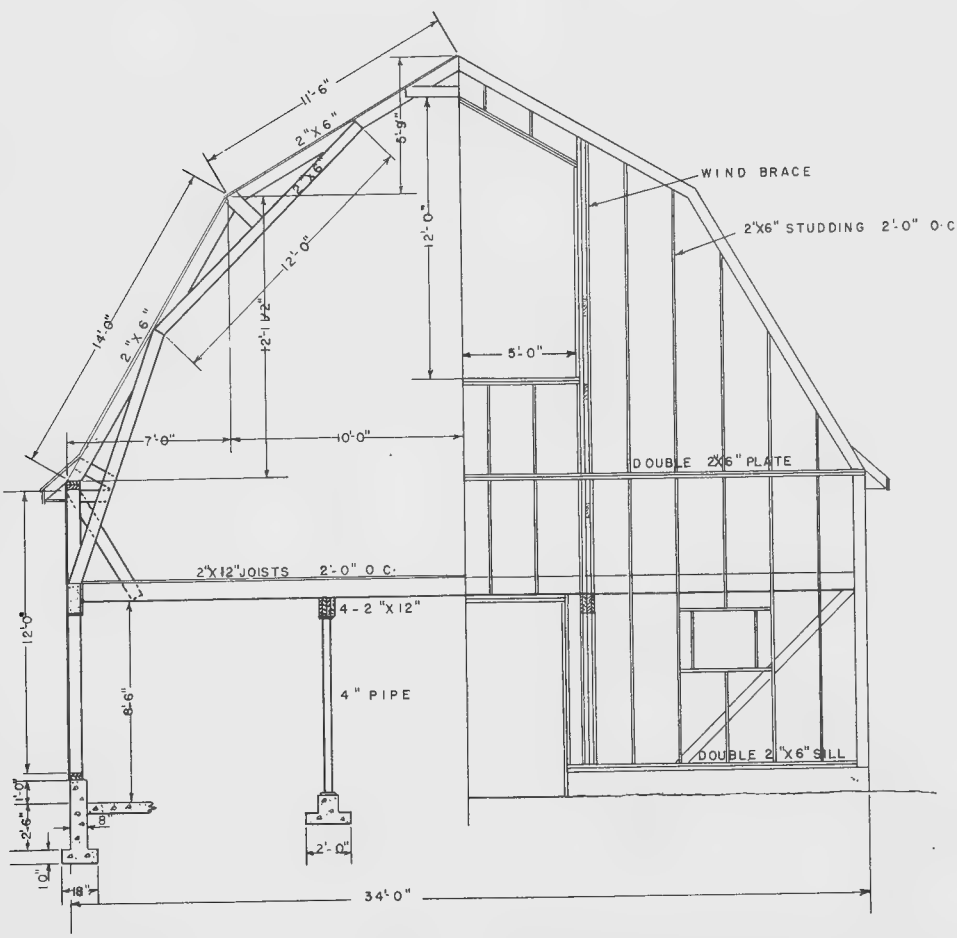


Figure 6.—Half section and half end framing of gambrel-roofed barn.

Windows and Doors

An allowance of 4 square feet of glass per cow with the windows uniformly distributed on both side walls is recommended. Window sills should be 3 to 4 feet above the floor in alleys, and higher in pens, to reduce glass breakage.

The minimum width of openings for "drive-through" barns is 8 feet. Single door openings should be 3 feet 6 inches to 4 feet wide. Doors for bull pens should be 4 feet wide. Hay doors should be 9 to 11 feet wide and 10 to 14 feet high where a fork is used, and 11 to 12 feet wide and 11 to 15 feet high where slings are used.

equally suitable unless large overhead bulk storage is actually required.

Gambrel Roof

Figure 6 shows a half sectional and half end elevation of the gambrel roofed barn pictured in Figure 5. The dimensions are for a barn 34 feet wide, and the framing details show a face-out stall arrangement.

Loft space may be increased by using 14- or 16-foot studding instead of 12 foot as shown. If less loft space is required, 8-foot studding can be used and the rafters brought right down to the loft floor.

There is a wide choice of roofing material. The roof may be sheathed

Modern stall-type dairy barn with milk-house attached.

BARN FRAMING

The traditional gambrel and Gothic arches provide a large loft space and are pleasing in appearance, but the advantage of a large loft under prairie conditions is questionable. Not only can hay be stored outside in our comparatively dry climate, but reduced bulk resulting from the increased use of baled hay and cut feed makes a large loft unnecessary. Barns with low gable roofs, or with bent laminated rafters, cost less to build and are

with shiplap, and then covered with cedar or composition shingles or roll roofing. Aluminium roofing is becoming popular. The corrugated type may be used satisfactorily without sheathing. Cross members, spaced about 2 feet on centres can be nailed to the rafters, and the rafters built up to the level of these cross members. The aluminium should be nailed to these cross members, and to the rafters.

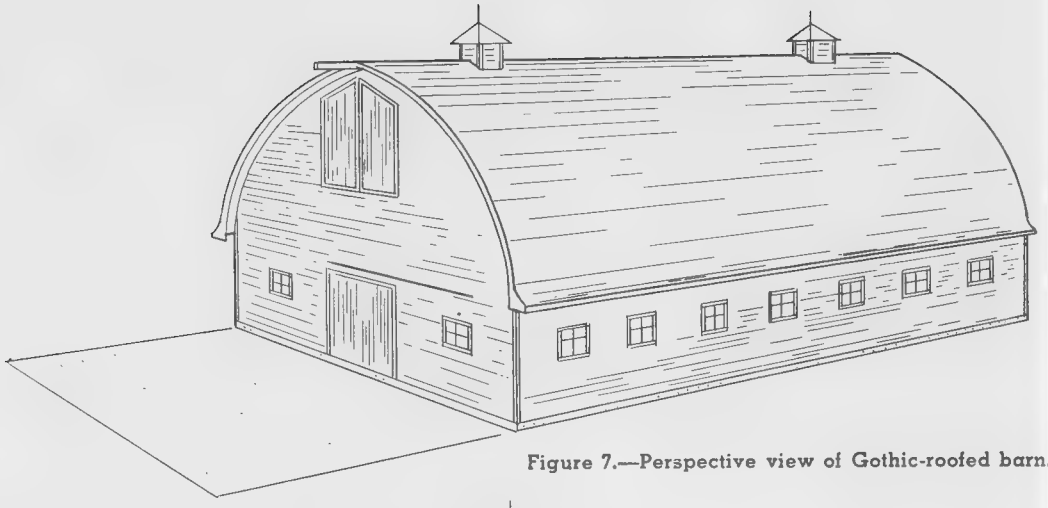


Figure 7.—Perspective view of Gothic-roofed barn.

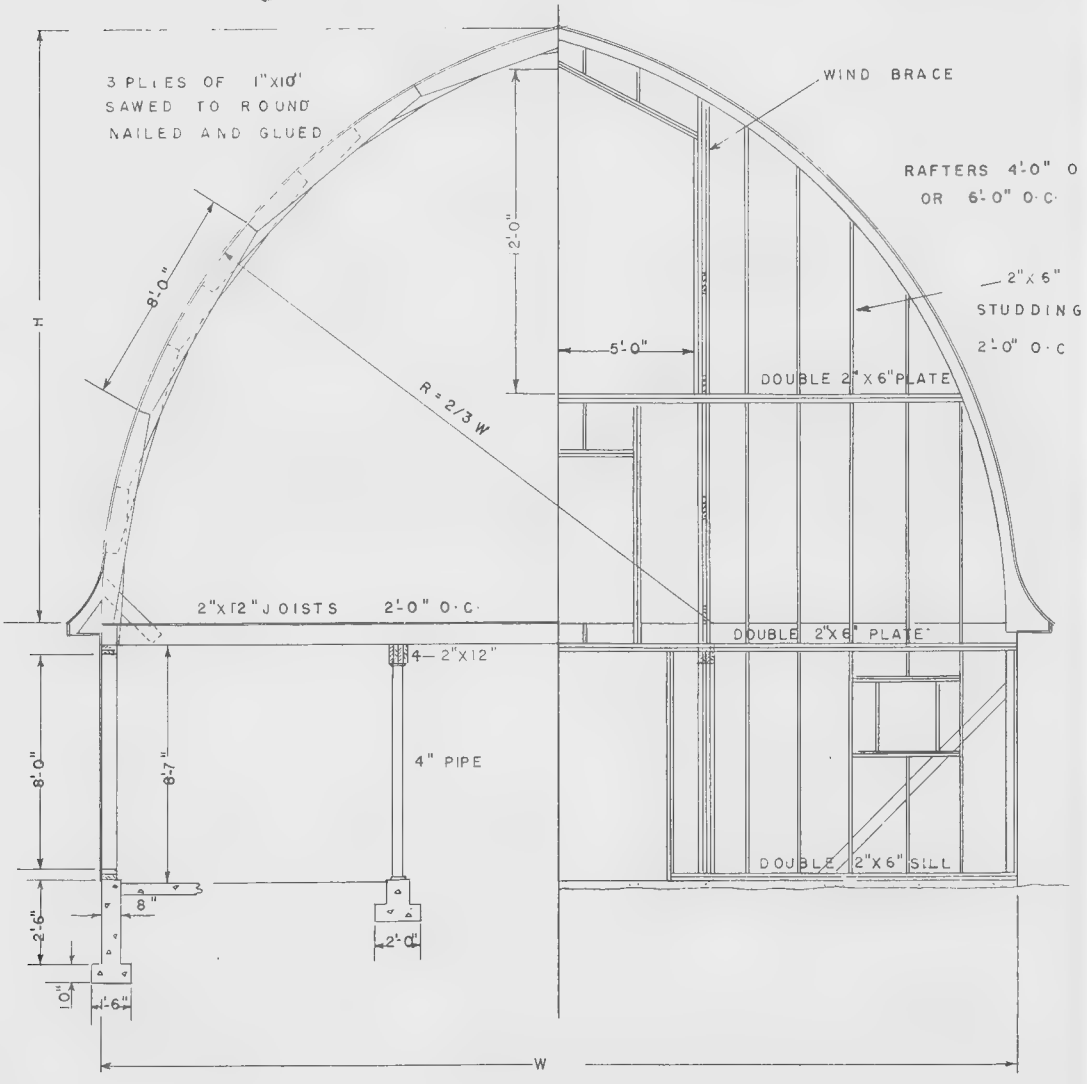


Figure 8.—Half section and half end framing of Gothic-roofed barn.

The columns supporting the loft floor are shown as 4-inch pipe. These columns may be built up by laminating 2 x 6's or 2 x 8's. Particular attention should be given to the footings under the columns, which should be of the dimensions shown in Figure 6. If the columns are placed on the barn floor without a concrete footing beneath the floor, the heavy loft load may cause the floor to crack.

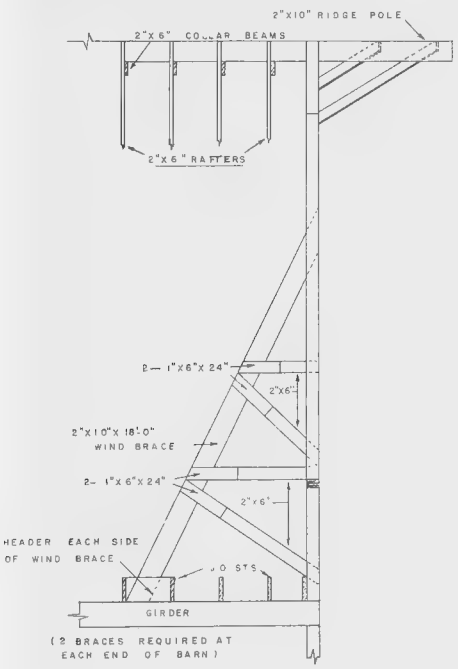


Figure 9.—Wind brace for gambrel or Gothic-roofed barn.

Gothic Roof

Figure 8 shows a half sectional view and a half end elevation of a barn with a Gothic roof. Figure 7 is a perspective drawing of a barn of this type.

The rafters shown are built up from three plies of 1 x 10 boards. Each board is sawed to form a segment of the arch, and the boards are nailed and glued together with the joints in each ply equally spaced with respect to the other two plys.

The strength of these rafters is greatly increased if they are well glued between each layer. Casein glue offers good protection against moisture, and is easy to use if the rafters are made during warm weather. The glue should be applied evenly, and the layers then nailed together. For best results from the glue, plenty of nails should be used. Smaller nails with closer spacing are much more satisfactory than larger nails spaced farther apart.

The radius to which the rafters are cut is usually two-thirds the width of the building. For a building 34 feet wide the radius will be 22 feet 8 inches. For a building 36 feet wide it would be 24 feet.

Round Roof

Round roofed buildings are becoming very popular as farm structures. They are well suited to dairy barns where a large loft space is not required. The bent laminated rafters may be bought, or built from ordinary one-inch lumber right on the farm. Construction of round-roofed buildings is dealt with in the section on Loose Housing barns, (page 25) so will not be dealt with here.

These buildings may be simple structures with the windows built into the curve of the wall, or they may be modified by the addition of eaves as shown in Figure 10.

Some people prefer the appearance of a peaked round-roofed building. This may be built into the rafters as shown in Figure 11.

Gable Roof

Figure 13 shows a half sectional view and end framing details for a low gable-roofed barn 34 feet wide, with face-in stall arrangement. A perspective view is shown in Figure 12. This barn design offers very limited hay storage but has the advantage of cheaper construction. If no loft storage is wanted, the framing for the ceiling can be made lighter and a further saving realized.

As with the other types of barn roofs, there is a wide choice of roofing materials. The roof may be sheathed with shiplap or boards and covered with wood or composition shingles, or metal roofing may be applied as outlined for the gambrel-roofed barn.

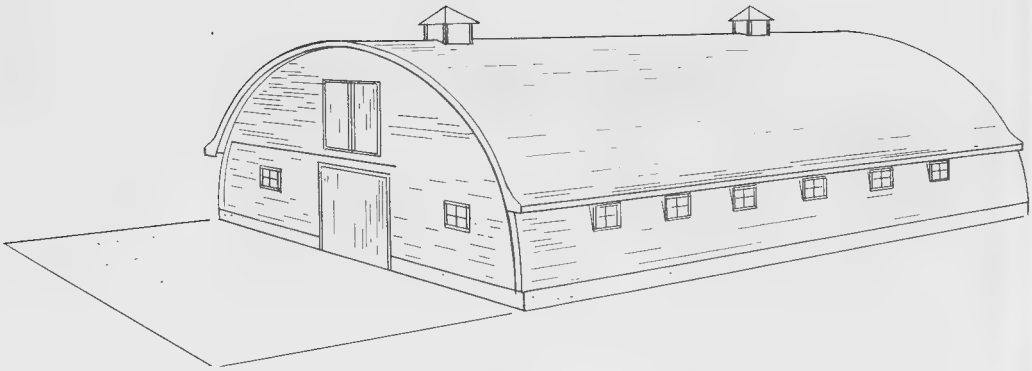


Figure 10.—Perspective view of round-roofed barn.

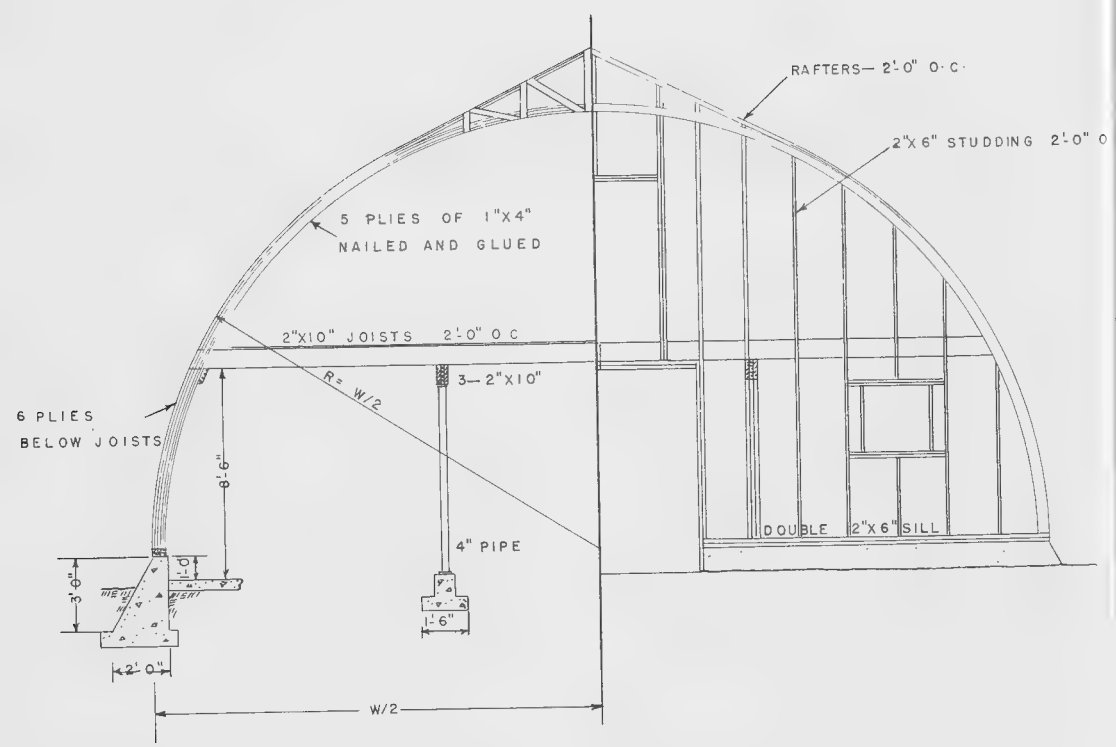


Figure 11.—Half section and half end framing of round-roofed barn.

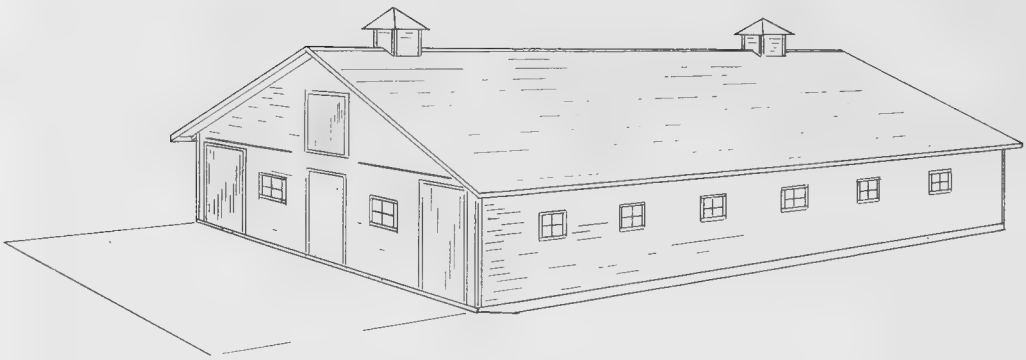


Figure 12.—Perspective view of gable-roofed barn.

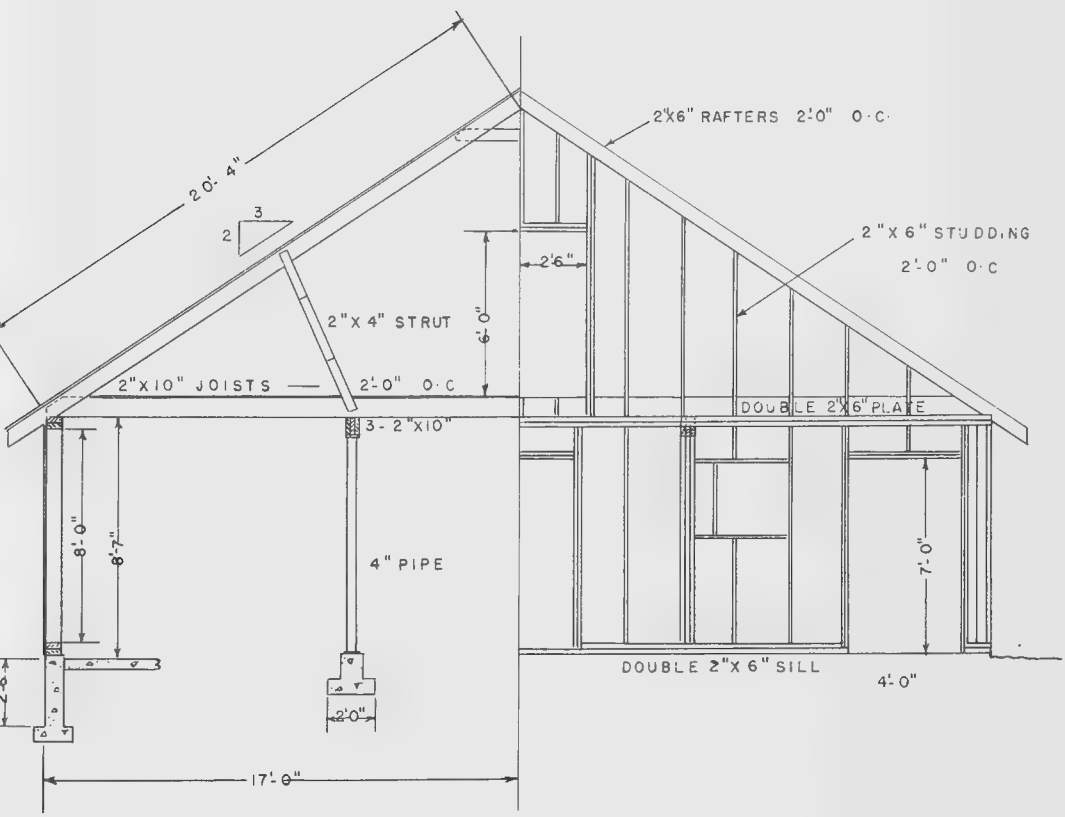


Figure 13.—Half section and half end framing of gable-roofed barn.

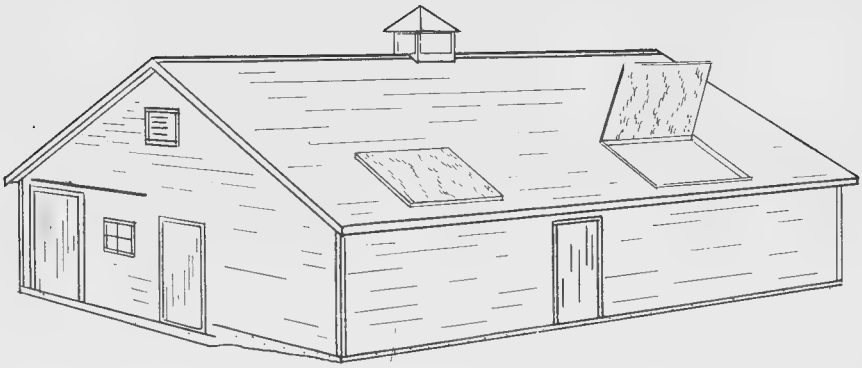


Figure 14.—Perspective view of single row dairy barn.

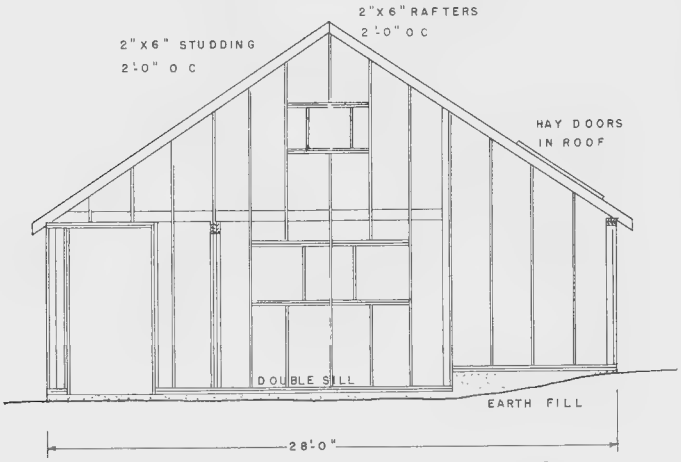


Figure 15.—End framing of single row dairy barn.

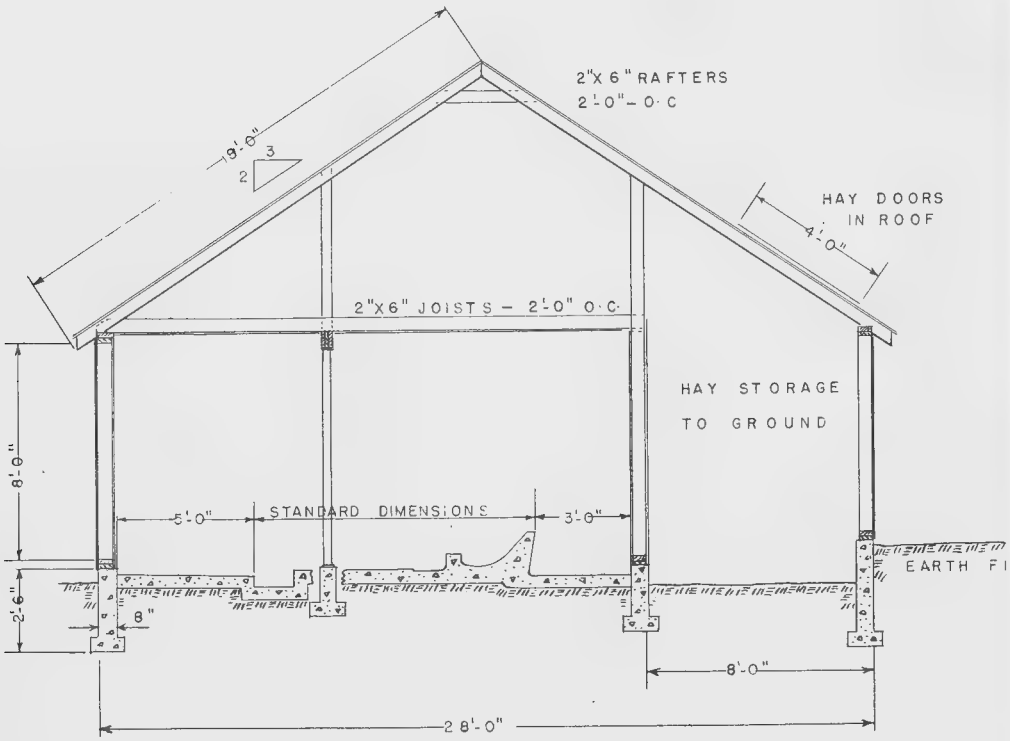


Figure 16.—Section of single row dairy barn.

SINGLE ROW DAIRY BARN

For small dairy herds a single row of stalls is advisable. This arrangement allows for a simpler structure, and makes the storage of hay on one side of the building possible. It also keeps the building cost down to a reasonable figure.

Figures 14, 15 and 16 show a small gable-roofed barn with a single row of stalls. This barn provides hay storage along one side of the barn rather than in a hay loft. The diagrams show hay doors built into the roof so that the storage space can be more completely filled.

The wall between the stable and the storage space should be well built and insulated. This prevents loss of heat from the stable, and does away with the need for insulating around the whole of the storage space.

A barn of this type should face south, with the hay storage on the north. This allows a maximum amount of sunlight in the stable area.

VENTILATION OF STALL TYPE DAIRY BARNS

Ventilation provides that degree of temperature and humidity in the barn that best favours health and comfort of the dairy cow. The following suggestions refer to stall type barns only. Conditions are quite different in loose housing units where the cows are free to move around.

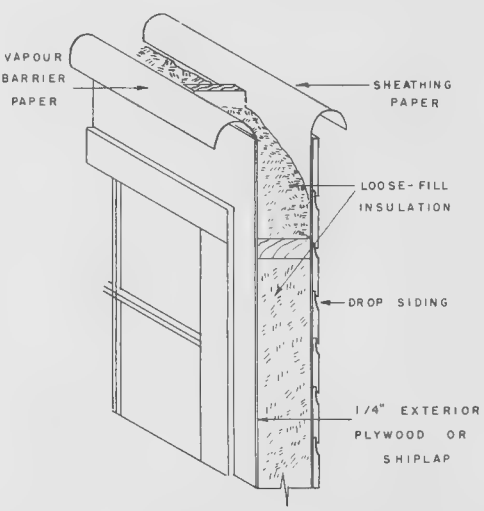
In the stall type barn air temperature in winter should be between 40° and 50° F. Relative humidity should not be more than 75% under normal conditions and from 85 to 90% on extremely cold days. Two conditions have to be met — temperature control and humidity control.

Warmth comes from the body heat of the cows, but they also breathe out large quantities of moisture, which must be removed from the building by ventilation. Ventilation draws off this moist air and replaces it with dry outside air. The cold air in the barn becomes warm, takes up the moisture, and is then drawn off to complete the cycle.

The amount of air required for ventilation depends on the amount of moisture given off by the stock in the barn, but much of the heat given off is lost in the ventilating air, leaving only a small amount of heat to keep the barn at the desired temperature. This brings up one of the most important ventilating problems.

If the barn walls and ceiling are not well insulated there is not enough heat to keep the stock comfortable, and the only solution is to reduce the ventilating rate. This in turn increases the humidity which shows up as condensation and frost on the walls, ceiling and other parts of the barn. There are then two essentials for proper conditions in the barn :

1. The ventilating rate must be sufficient to keep the moisture level (or humidity) low.
2. The barn must have sufficient insulation so that during cold weather the ventilation will not have to be reduced to the point where condensation occurs on walls or ceilings.



Wall and Ceiling Construction

For satisfactory ventilation the walls and ceilings must be properly constructed. Figures 17 and 18 provide sectional views and show essentials of well insulated walls and ceilings. It is the insulating material rather than the sheathing and siding that prevents loss of heat. From the point of view of warm construction, the outside or in-

Two-fan ventilation system with slot inlet from loft.

side finish of the barn is of little importance providing 4 to 6 inches of insulation is used in the walls and 6 to 8 inches in the ceiling. Planer shavings may be used for insulation.

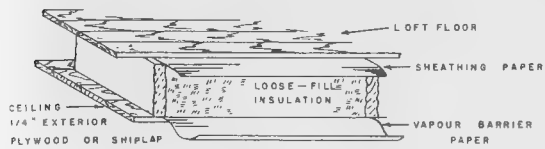


Figure 18.—Details of ceiling section.

Vapour Barrier

Vapour barriers are important. Water vapour from inside the barn passes through ordinary building materials. It condenses in the insulation, spoiling the value of the insulation and rotting the studding and joists. Because of this, a vapour barrier should always be used and must be placed immediately under the interior sheathing.

Vapour barrier paper can be bought, or plywood used for lining the barn can be made vapour resistant with two coats of asphalt paint or rubber base paint applied to the inside of the plywood — the side against the studding.

The vapour barrier should never be placed outside the insulation. Ordinary building paper or tar paper is not a vapour barrier, and should never be used for this purpose.

VENTILATING SYSTEMS

There are two methods of barn ventilation, natural and mechanical. Either is satisfactory as long as it allows sufficient air change.

Natural or Gravity Ventilation

With gravity ventilation, warm air is removed from the barn by an out-take flue, and fresh air is admitted by inlet openings. There are two common systems of natural ventilation; the King system and the Rutherford system. In the King system the out-take flue extends right down to floor level while the inlets are at ceiling height. In the Rutherford system the outside flue is at ceiling height and the inlets are near floor level. A modified system having both the inlet openings and outlet flue near ceiling level has also proved very satisfactory. All data outlined here for the King system apply equally to this modified system, except that the outlet flue in the modified system starts at the ceiling.

Location of the Out-take Flue

The out-take flue is usually placed where it will cause least inconvenience in the barn — in the corner of the feed room or calf pen facing on the centre alley. As far as operation is concerned this location is not important as long as it is not too close to a poorly fitted door. In its passage from the ceiling to the ridge the flue should be kept as straight as possible. Sharp bends greatly reduce its efficiency.

Size of the Out-take Flue *

The capacity of the out-take flue varies with its vertical height; that is, the higher the flue the more air will it move per square foot of its cross-sectional area. The amount of out-take area to be provided per cow or per animal unit will therefore depend on the height of the out-take. The first thing to do then, is to measure the height of the barn from the stable floor vertically to the ridge of the roof, since the ventilator head must in all cases be run up to a point two feet higher than the level of the ridge.

The next thing is to find the number of animal units for which the system is to provide ventilation. For this purpose each mature cow is taken as an animal unit while young cattle and calves are "lumped" in groups of 1,000 pounds to reduce the capacity of the stable to animal units. When this has been determined, the following method may be used to find the total out-take area: Run down the left hand column of Table III to the figure representing the number of animal units in the stable, then following this line to the right, the out-take flue area needed will be found in the column headed by the figure nearest to the height of the out-take in your barn.

* Reprinted from Dairy Barn Ventilation, Bulletin No. 5, Macdonald College.

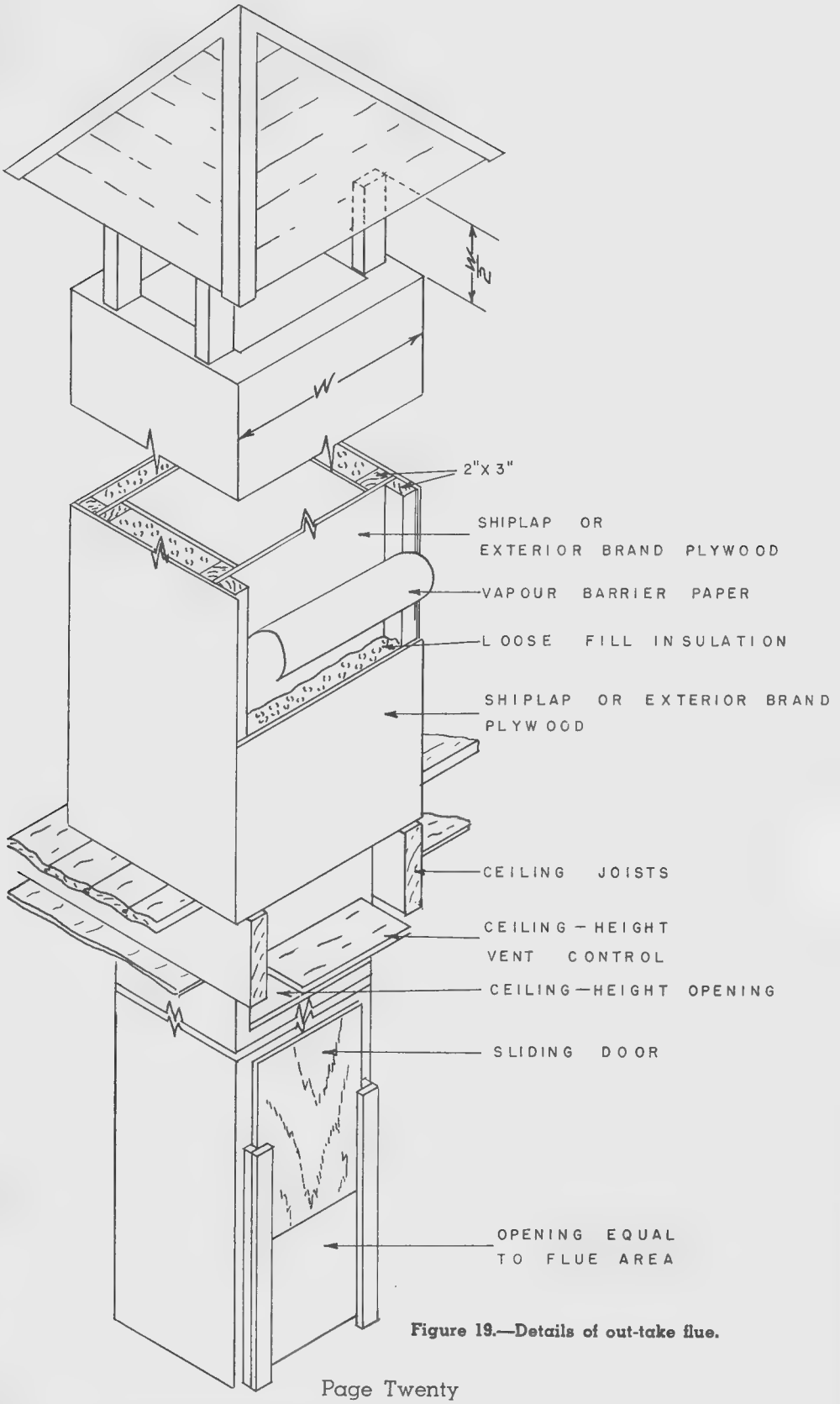


Figure 19.—Details of out-take flue.

TABLE III

Flue areas needed for various numbers of cows or A.U. and height of barn.

Number of Cows or A.U. in Stable.	Height, in feet, from stable floor to ridge of barn.						
	20	25	30	35	40	45	50
	Flue area needed (sq. ins.)						
10	430	362	318	287	264	246	230
11	474	396	350	316	291	270	253
12	518	435	382	345	317	294	276
13	560	468	414	373	343	320	300
14	604	507	445	403	370	344	323
15	646	540	477	430	396	369	346
16	690	580	510	460	424	394	369
17	731	613	541	488	450	418	392
18	776	654	573	518	476	443	416
19	818	685	605	545	502	467	438
20	864	726	637	575	529	492	461
21	905	756	668	603	555	517	474
22	954	800	698	630	579	545	511
23	990	829	732	660	608	566	530
24	1,039	870	766	690	639	587	554
25	1,078	900	796	718	660	615	575
26	1,122	945	826	749	698	639	604
27	1,160	974	860	775	714	665	621
28	1,210	1,020	894	810	740	689	647
29	1,250	1,042	922	832	766	714	668
30	1,292	1,090	961	860	792	741	690

Example :

To illustrate the use of the table, it is assumed a single out-take King system is to be designed for a stable housing 18 cows, 1 bull, 4 heifers (averaging about 500 pounds), and 7 calves. The mature animals count as one A.U. each, the heifers make up 2 A.U. and the calves 1. This makes a ventilation load of 22 A.U.

The vertical height of the building from the stable floor to the ridge of the roof is almost 35 feet.

From the table, the cross sectional area of flue required is 630 square inches.

Construction

The flue should be lined with smooth boards, preferably running vertically. It is very important that the out-take flue be insulated to prevent condensation and frost. Three inches of shavings are satisfactory for insulation, and of course a vapour barrier must be employed. Out-take flue construction is shown in Figure 19.

Size and Location of Air Inlet Openings

The total cross-sectional area of the inlet openings should be equal to about 80 per cent of the area of the out-take flue. This area must be broken up into a number of small openings

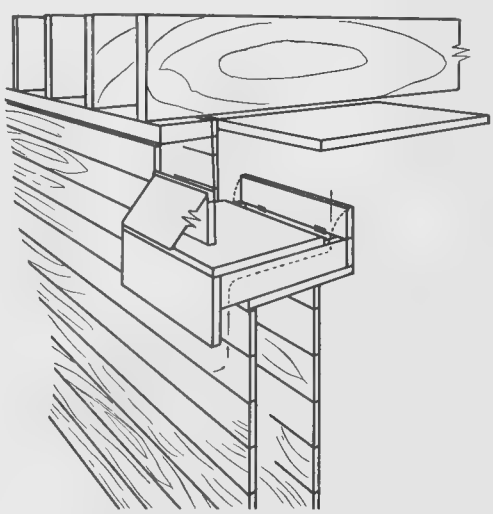


Figure 20.—Typical inlet construction.

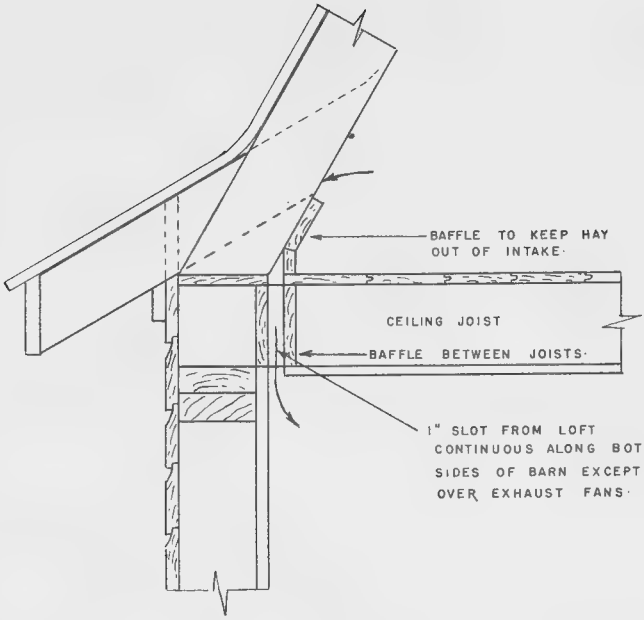


Figure 21.—Slot-type inlet.

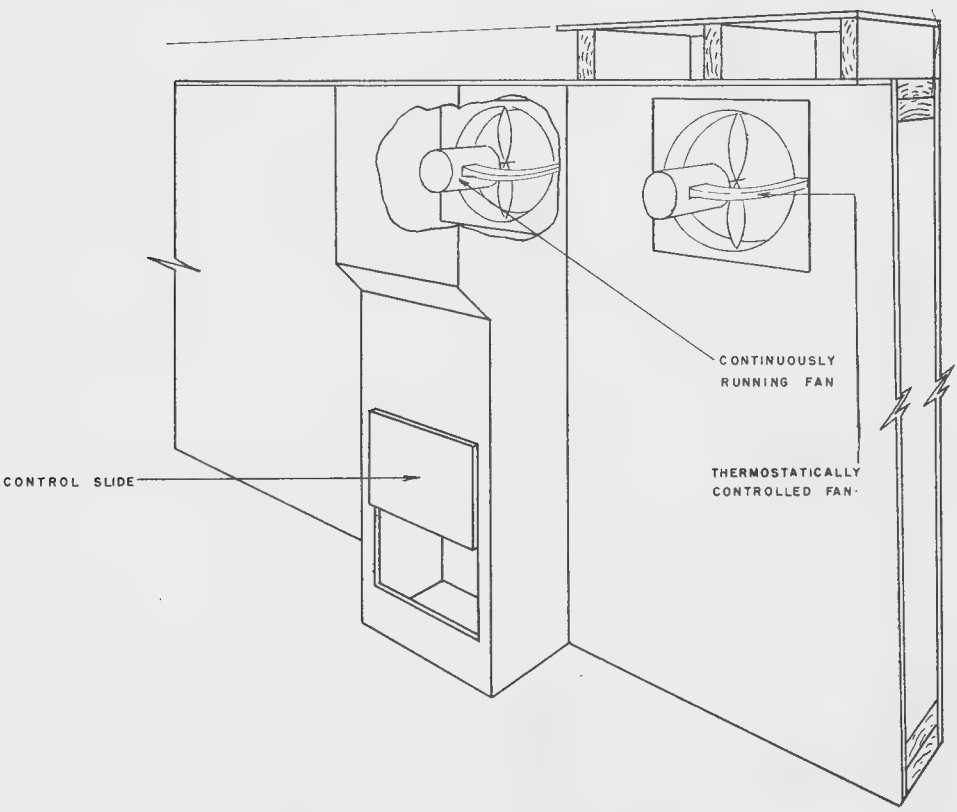


Figure 22.—Two-fan ventilation system.

distributed evenly around the stable. To prevent the admission of too much cold air in one spot, inlet openings should not be larger in cross-section area than 50 square inches, and the recommended size is from 40 to 42 square inches. Inlets are commonly 3 x 14 inches or 2 x 22 inches depending on whether 16 or 24-inch stud spacing is used. Typical inlet construction is shown in Figure 20. The opening inside the barn should be 12 inches below the ceiling.

In locating the inlet openings, it should be remembered that, while even distribution around the stable is desirable, no inlet should be located closer to the out-take than 8 feet.

FAN VENTILATION

Electric fans may be used instead of the outlet flue to exhaust the air from the barn. Ventilating fans are rated as to the volume of air they will discharge — the capacity in cubic feet per minute. (cfm). The ventilation rate in a dairy barn should be about 60 cfm per animal unit. For a barn housing 20 dairy cows, a 1,200 cfm fan should prove suitable.

Thermostatic switches are used with the fans so that as the barn temperature rises more air is exhausted and the temperature returns to normal. Two fans are usually needed for effective temperature control. A typical installation is shown in Figure 21. One fan runs continuously and draws air from the floor at a rate of 40 cfm per animal unit. The other fan, drawing air from ceiling level at a rate of 60 cfm, cuts in thermostatically at a temperature of 50° F. and continues to run until the temperature drops about three degrees.

The best place for ventilating fans is at the centre of the leeward side of the barn. They should be equipped with automatic shutters to prevent back drafts when the fans are not operating.

The inlets may be similar to those mentioned in the section on natural ventilation (Figure 29), or they may be slots leading from the loft as shown in Figure 21. These slots should be about 1 inch wide and should extend along both sides of the barn except for a distance of 10 feet on either side of the fan.

Fan ventilation will give positive control of the ventilating rate, but will not prevent condensation and frost in a poorly insulated barn. Both natural draft and fan ventilation systems will operate satisfactorily only in a tight, well insulated barn.

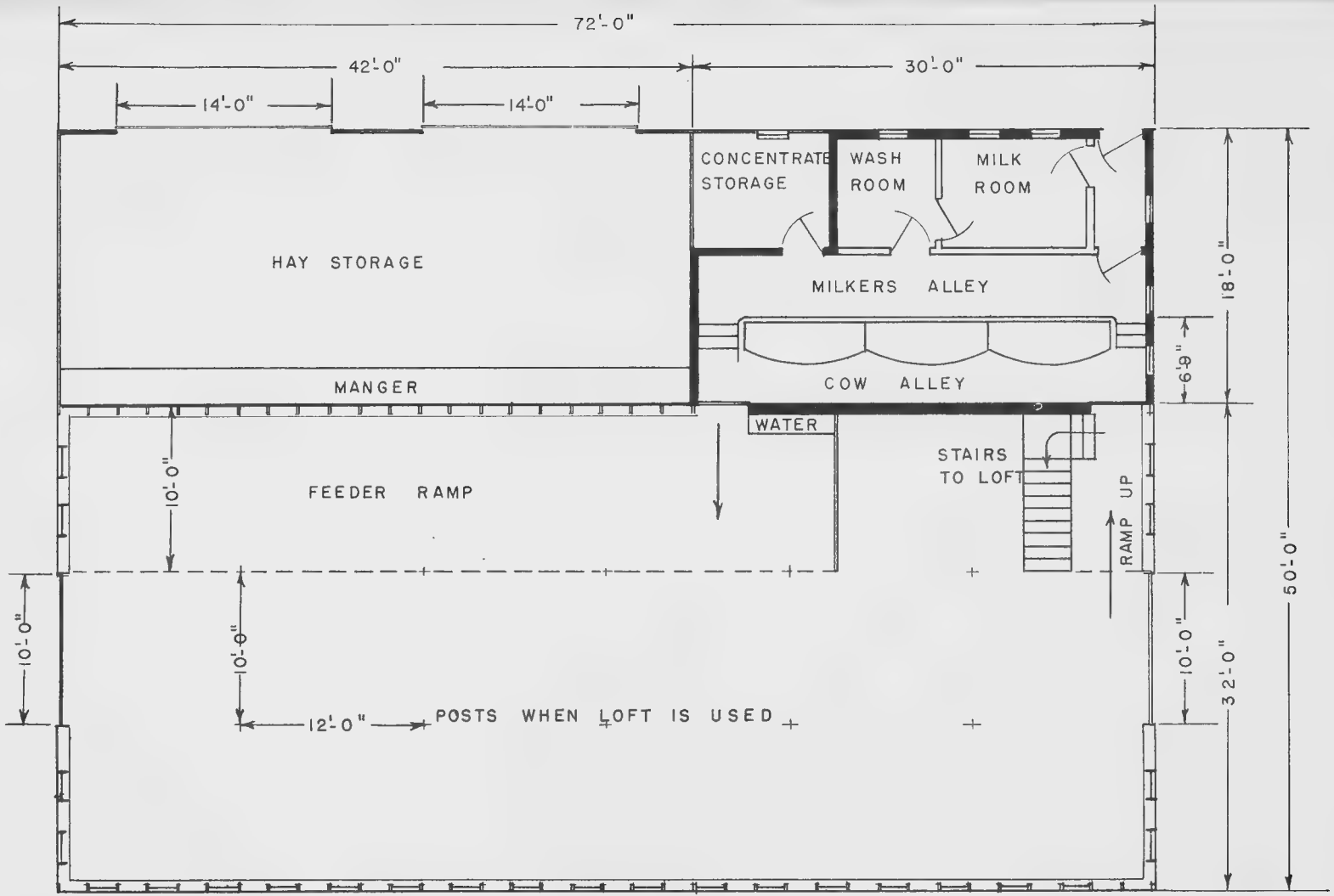


Figure 23.—Floor plan of loose housing barn with storage and milking room on one side. Floor area sufficient for approximately 25 cows.

LOOSE HOUSING BARNS

Shortage of farm help has done much to arouse the interest of farmers in the loose-housing system of managing dairy cows. Although practised in the United States for many years, it was not until 1948 that the system first appeared in Alberta.

Much less labour is needed for loose housing than with the stall barn, particularly in milking and barn cleaning. Then, too, this production-line system of bringing cows to the milker reduces the drudgery often associated with the milking chore.

Modern loose-housing dairy barn with milk area on one side and feed storage on the other.

The main features of a loose housing system are :

(1) The feeding and resting area in which the animals run loose except at milking time.

(2) The milking room or milking parlour where the cows are milked and fed their concentrate.

The Feeding and Resting Area :

The manure is left on the floor of the loose housing area during the winter, and sufficient bedding added to keep the surface clean. At the end of the season the manure pack is removed with a power loader and spread directly onto the fields.

Since there is no need for the air to be too warm in the loose housing area, ventilation can be provided by opening doors and windows. The heat generated in the manure pack assures a warm bed for the stock.

The Milking Room

After a short period of training the cows wait to enter the milking room at milking time. They are held there only long enough to be milked and to eat their concentrate.

This portion of the building is insulated and heated for comfort.

Pros and Cons of Loose Housing

Experiment and experience both show that loose housing barns are well suited to this climate, and that neither milk production nor milk quality are adversely affected. Under loose housing conditions, cows eat more roughage and less concentrate. This means lower feed costs since concentrate is usually the more expensive part of the ration. Cows running loose are less subject to udder and teat damage than those in stall barns.

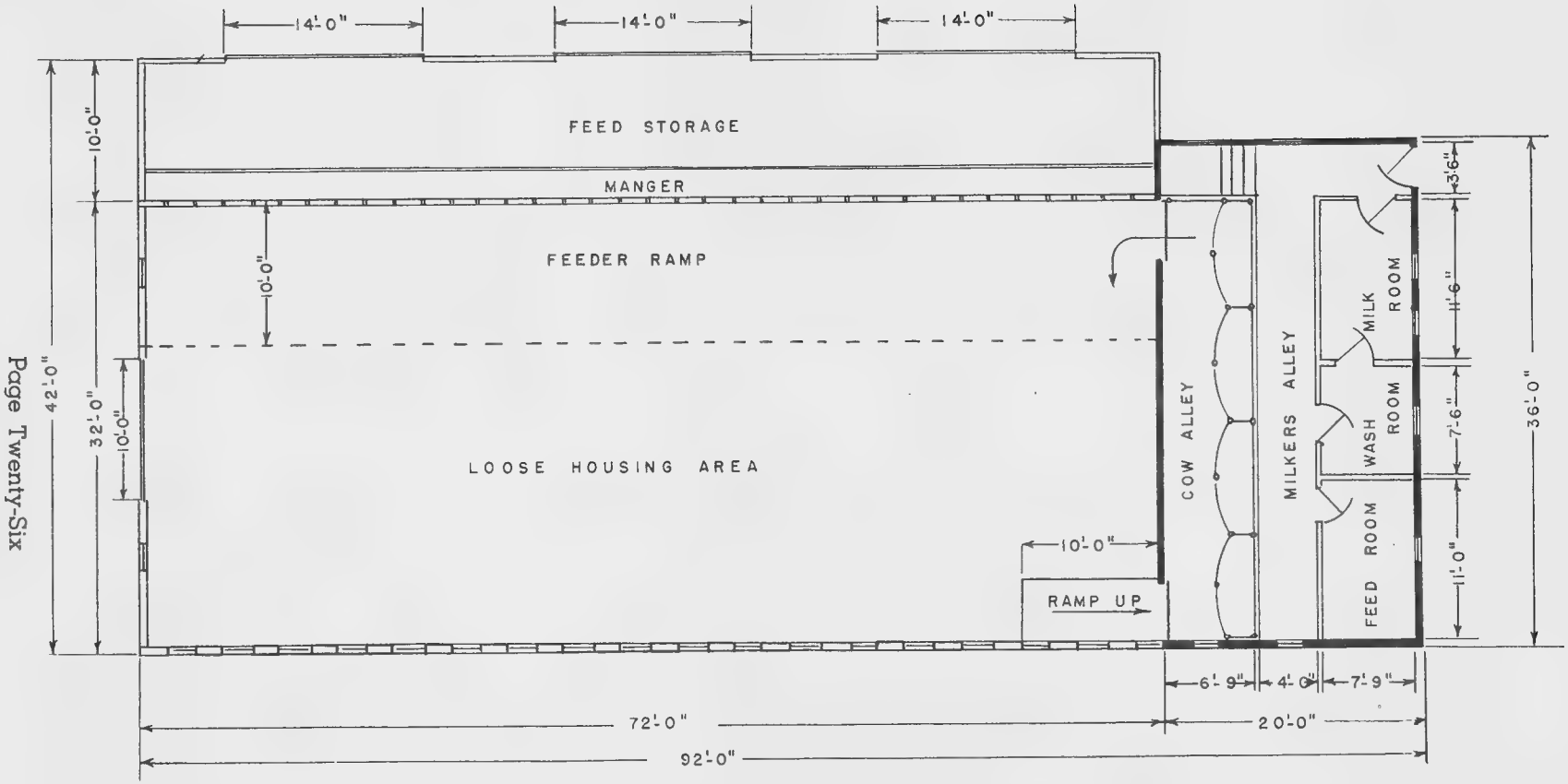


Figure 24.—Floor plan of loose-housing barn with milking room at one end and feed storage on one side. Floor area sufficient for approximately 25 cows.

Since the surface of the manure pack must be kept dry, more bedding is needed than in the stall barn. Some operators have complained of trouble with boss cows; others say that under this system their cows do not "show" as well. Except for these minor disadvantages, the loose housing system has proved very satisfactory and is well worth considering by those who have, or wish to start a dairy business.

BARN DESIGN

In the stall-type barn established floor plans are in general use. Plans for the loose housing barn are constantly being modified and improved to meet our conditions. The plans in this booklet are typical of the most efficient units in operation in the province today. They show all areas of the system in one building. That is the only type used on the prairies at present but it does not mean that separate buildings for the different areas may not prove suitable.

In planning the loose housing barn the first thing to consider is the size of the herd. Each cow will need about 80 sq. ft. of space. This includes the resting and feeding area, but not the milking room. The next point is whether to use a self-feeder or feed bunks. If feed bunks are used a length of 30 inches will be needed for each cow. With a self-feeder 18 inches is enough, since with the feed always available the cows will not all be eating at the same time.

A sloping concrete ramp up to the feeder is worth while for two reasons. The ramp helps to keep the manger clean, and also discourages the cows from lying down in the feeding area.

Hay is usually stored on the ground level near the manger. This reduces labour as compared with loft storage, and it also makes possible a cheaper building.

The manure pack provides a warm bed for the cows, but since it may build up to a depth of 4 feet, the design of the loose housing barn must allow for this. A clear height of 11 feet is needed, and the concrete walls should extend 4 feet above floor level to prevent contact of manure with the wood of the building. The doors must be large enough to allow easy entry of tractor-mounted manure forks. The resting area should be as free as possible from obstructions that would interfere with the operation of tractor-mounted equipment.

More bedding is needed for loose housing than for a stall barn, and a convenient area for bedding storage is necessary. Some operators store the bedding in the corner of the barn while others use an overhead loft. It is doubtful if the expense of a loft is warranted. With the use of a power fork the bedding can be moved into the barn from outside storage as needed.

As no attempt is made to keep the feeding and resting area warm, the structure should be as simple as possible. There is no point in using insulated or even double walls. In fact the most common complaint, that of a wet manure pack, is nearly always due to the barn being kept too warm.

Ventilation is provided by simply opening the windows and doors. Fans or expensive flue systems are not needed in loose housing barns. Plenty of window space should be provided. A recommended figure is 4 sq. ft. per cow. The windows should be placed high so that they will not be damaged by the cows when the manure pack builds up.

The milking room is usually close to the loose housing area, and is built warmly for the operator's comfort. In the milking room the cow stalls are elevated about 2½ feet above the milker's alley so that he does not have to stoop and squat while washing and milking the cows. Sloping ramps are built to and from the milking room so that the cows walk in at the level of the elevated stalls. Details of milking rooms and milk handling areas are discussed in the section on milking rooms (page 37).

FLOOR PLANS

Figure 23 shows the floor plan of a loose housing unit in which the hay storage, milking room, milk room, wash room and concentrate storage are built on the north side of the barn. The main barn contains the resting area,

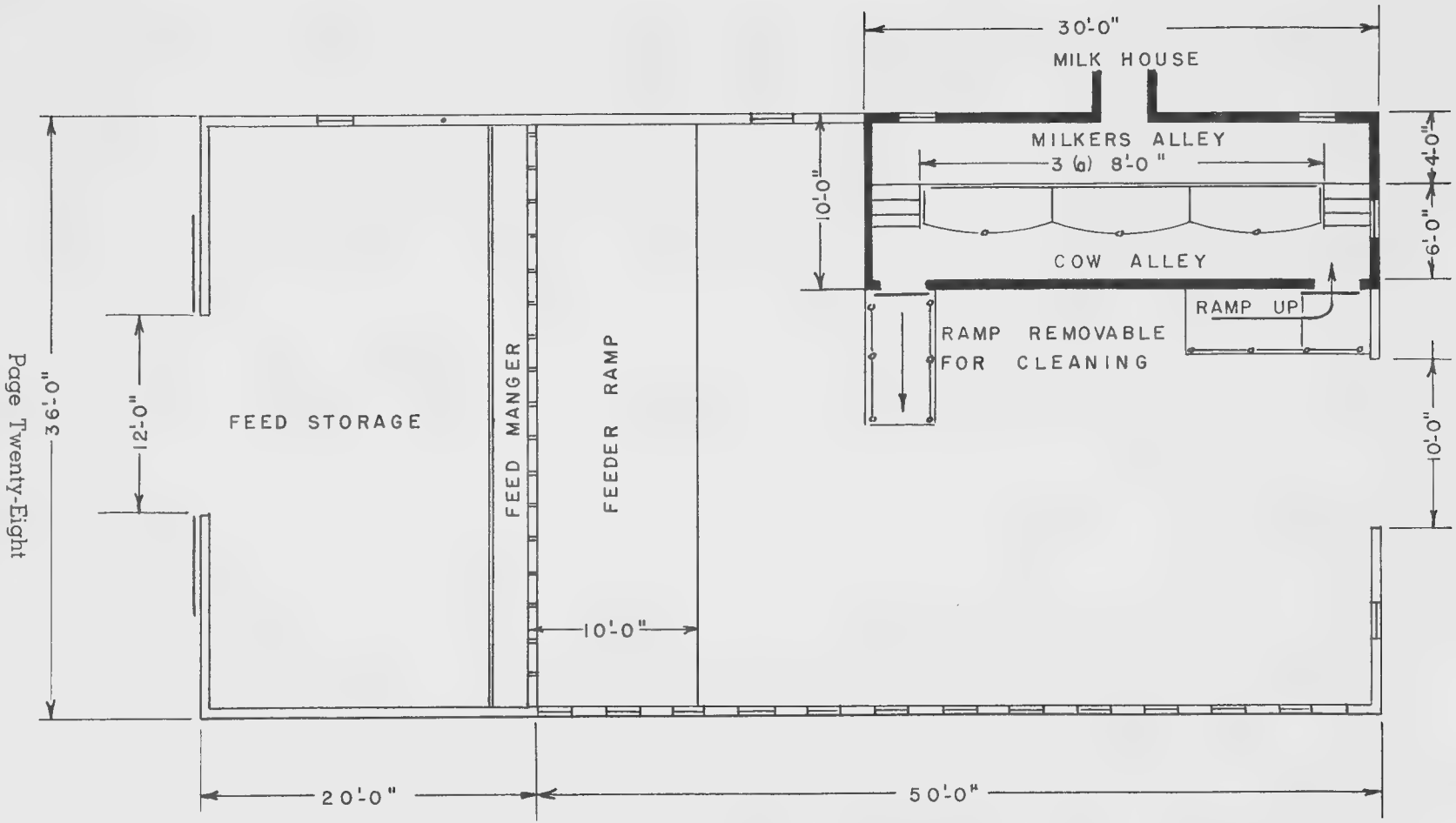


Figure 25.—Floor plan of loose-housing barn with feed storage and milking room inside the barn. Floor area sufficient for approximately 18 - 20 cows.

Interior view of loose-housing unit, showing resting area and ramp to side feeder. Note guillotine-type door in end of barn.

and the ramp leading to the feeder. The water trough is shown at one end of the feeder ramp, the elevation helps to keep both the water and the surroundings clean. Ramps to and from the milking room are shown. All of these ramps should extend back into the barn at least 10 feet, as a slope any greater than 1 to 5 is dangerous to the cows.

The posts shown in the plan are necessary if the barn is built with a loft. For easier cleaning, these posts should be so constructed that one post at a time can be removed. Also to make cleaning easier the footings under the posts should be flush with the floor. The doors shown in the plan are 10 feet wide, but care should be taken to see that the doors in any particular barn are wide enough to allow easy entry and operation of a tractor-mounted manure fork. The spacing of any supporting posts should also be carefully watched for this same reason.

The doors on the hay shed are made so that the hay may be brought in directly with a sweep stacker. The doors are hung on a continuous track extending sufficiently far across the

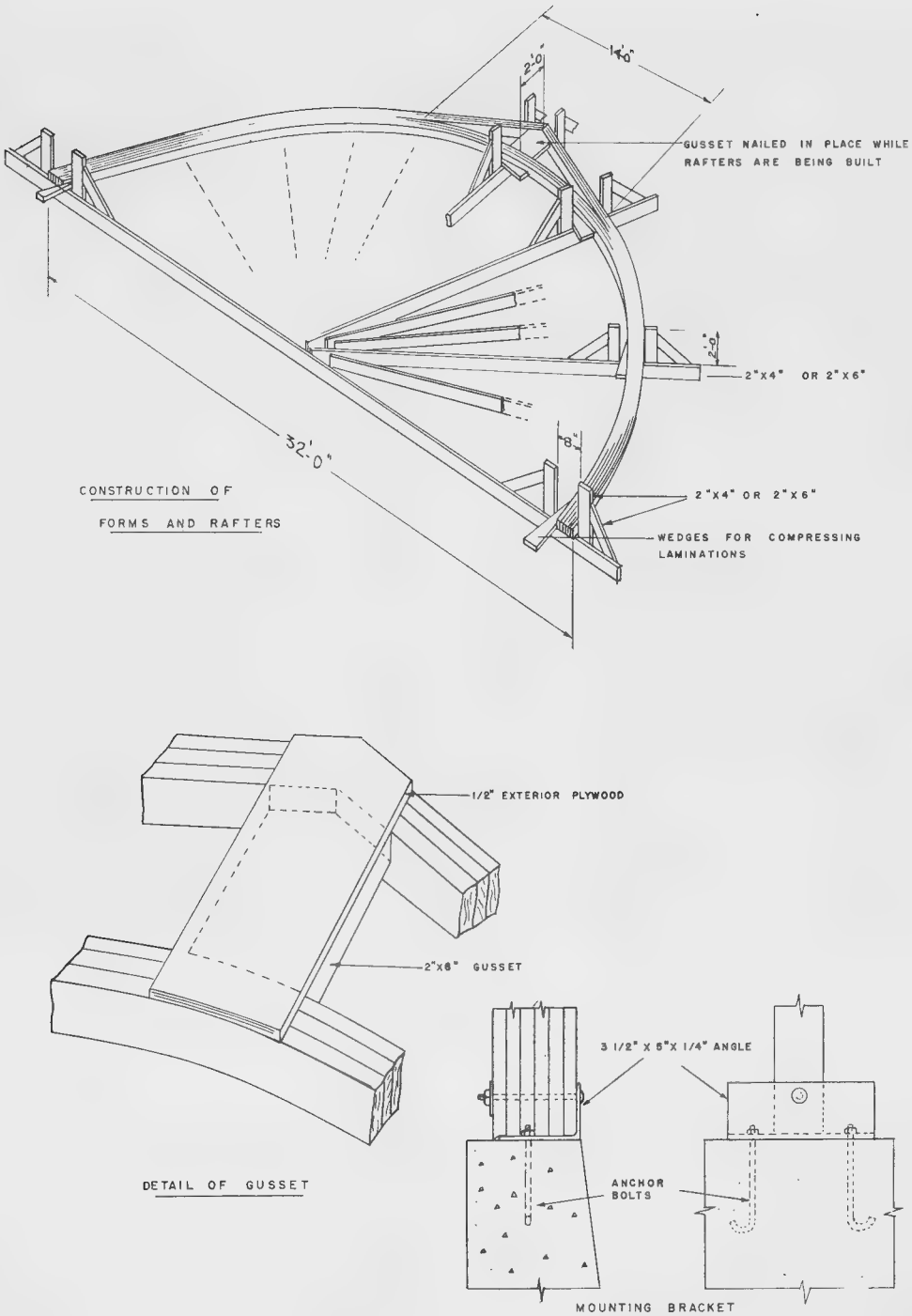


Figure 26.—Bent laminated rafter construction.

concentrate storage room to allow either of the large doors to be fully opened.

Details of the milking area and milk handling area are discussed in the section on Milking Rooms (page 37).

Figure 24 shows the plan of a loose housing barn with feed storage on one side of the barn, and the milking room built across one end of the barn. This style allows much more feeder space, but has the disadvantage of allowing only one end door. The lean-to shown in the plan is 10 feet wide. This is wide enough if baled feed is used, but where long hay is fed the width may be increased. The doors shown are suitable for long hay handling, and as in the previous plan are hung on a continuous track.

Figure 25 shows the floor plan of a loose-housing barn in which the milking room and feed storage are both built within the barn proper. Modifications of this plan may be useful in converting old barns to loose-housing units. The inside milking room is particularly adaptable where the barn is wide. Removable ramps may be used for easier cleaning in the area around the milking room.

BARN FRAMING

Large lofts and gambrel or Gothic arched rafters are not needed in the loose housing barn. Lower buildings are much more suitable and they cost less. A building without a loft is preferable, and should be designed so that pillars are not needed. One building of this kind is a semi-circular roofed unit using bent laminated rafters. Another is a gable roofed building in which roof trusses are used instead of pillars.

The semi-circular or round-roofed building is very strong and is easier to build than most people believe. Figure 28 shows a half section view and end framing details. Figure 27 provides a perspective view of the building. The barn shown has a loft for bedding storage, but unless loft space is required the loft joists and pillars need not be included. They are not needed to support the roof.

The barn in Figure 28 has the mangers and feed lean-to on the side. The ramp leading up to the mangers consists of an earth fill covered with concrete. The concrete of the ramp should be roughed with a stiff brush while setting to afford better footing for the cows. The foundation walls are shown tapered out to a width of 2 feet at the bottom. This is necessary in round-roofed structures since the rafters exert a force outward on the foundation walls.

Figure 26 shows how bent laminated rafters are built. A form for the rafters is first laid out on a level piece of ground. The rafters are then built up by bending the 1 x 3's into the form in consecutive plies. Glue is spread on each ply before it is placed in the form. Before nailing, wedges are used to squeeze this ply against those that have already been assembled. Glue should be used for rafters built in this manner as they are much stronger than those which are simply nailed. Moisture-resistant glue must be used, and the most readily available is casein glue. This comes as a white powder and is mixed with water before using. This glue is not difficult to use if the weather is reasonably warm and will make a good bond with normal nailing pressure. To maintain a uniform pressure between all parts of the layer being glued, it is better to use a large number of small nails rather than fewer large nails. Two-inch nails spaced 8 inches apart are satisfactory.

After each rafter has been completed it can be removed from the form and placed elsewhere to dry. The ends of the rafters do not spring apart upon being removed from the form.

When all the rafters have been completed, they may be erected on the foundation. Figure 26 shows a method of fastening the rafters to the concrete foundation. The building is then ready for the end framing and covering. Horizontal, or preferably diagonal sheathing can be nailed to the rafters, then the building can be shingled or covered with aluminum or good quality roll roofing.

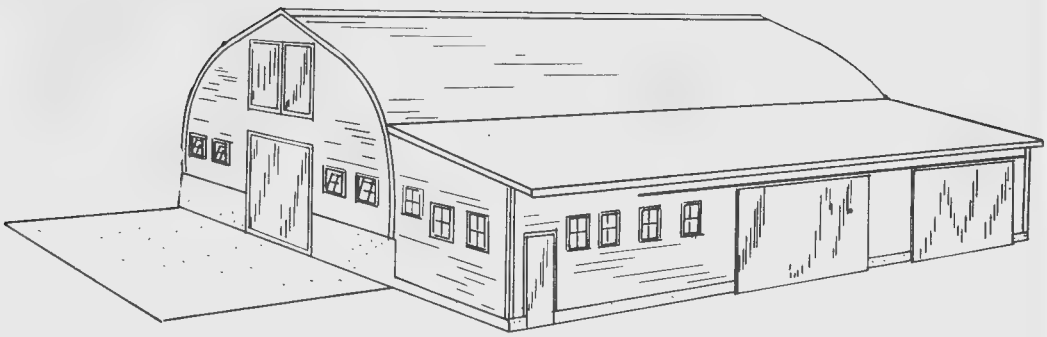


Figure 27.—Perspective view of loose-housing barn with milking room and feed storage on one side.

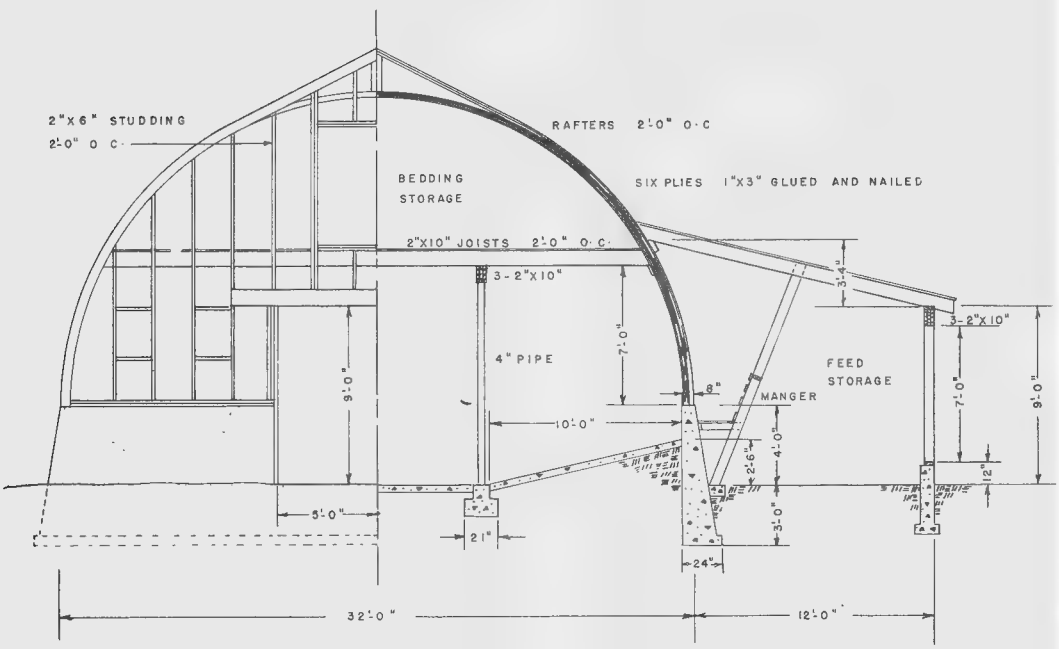


Figure 28.—Half end framing and half section of loose-housing barn with side feeder and loft for bedding.

Corrugated aluminum or steel roofing can be used without solid sheathing as shown in Figure 29. If this procedure is used with aluminum roofing it is advisable to board the first four or five feet of wall in solidly to prevent the cows from damaging the soft aluminum.

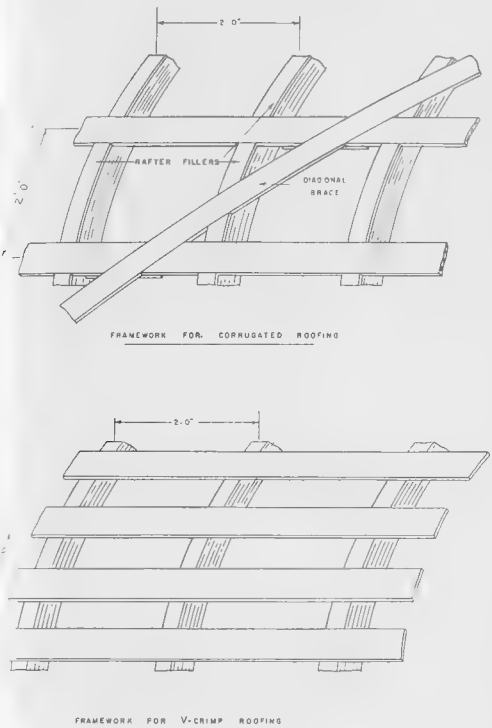


Figure 29.—Battens for metal roofing.

The windows can be fitted between the rafters and should be hinged so that they will swing inward at the top for ventilation.

The large end doors should lift vertically instead of sliding horizontally. Horizontal sliding doors are difficult to close when the manure pack builds up. The vertical doors can simply be lowered to the level of the manure pack. Vertical sliding doors should be counterweighted, and the counterweights should be hung on steel cables. Steel cables are needed as a precaution in case of fire. Ropes would burn through quickly and allow the doors to drop shut.

Figure 31 shows a gable-roofed loose housing barn with trussed rafters. These rafter trusses should be constructed on the ground, then placed on the walls after the rafters have all been built. The trussed rafter design allows the entire barn area to be kept free of pillars or supports.

As with any other type of loose housing structure, the concrete foundation should extend four feet above floor level.

No provision for feed storage is shown in Figure 31. A lean-to on one side may be used as in Figure 28, or hay may be stored in one end of the barn. Another method of roughage feeding is shown in Figure 30. Here a moveable self feeder is used in the barn yard. This method while not suitable for extremely severe days can be used to advantage during moderate winter weather, and reduces the amount of feed storage necessary in the barn. A solidly boarded fence on the north and west sides of the enclosure will permit outside feeding on a greater number of winter days.

As with the round-roofed building, the wall and roof construction should not be designed for warmth. A single ply of drop siding is satisfactory for the walls, and the roof may be covered with any good quality roofing material.

The two building designs discussed here are suitable for anyone building a new barn specifically for loose housing requirements. However, many people have old horse or cattle barns that they would like to convert to loose housing units. This practice is entirely satisfactory providing that the ceiling height is sufficient to allow the cows head room after the manure pack has built up. Figures 32 and 33 show a horse barn before and after conversion to a loose housing unit. The headroom in this barn was about 10½ feet. The only changes necessary after the removal of the stalls were to build a four-foot concrete wall inside of the studding, and to build a milking room along one side of the barn. The rest of the lean-to shown is used for calf pens and horse stalls.

There are many older barns that could be more readily converted to loose housing units than brought up to date as stall type dairy barns.

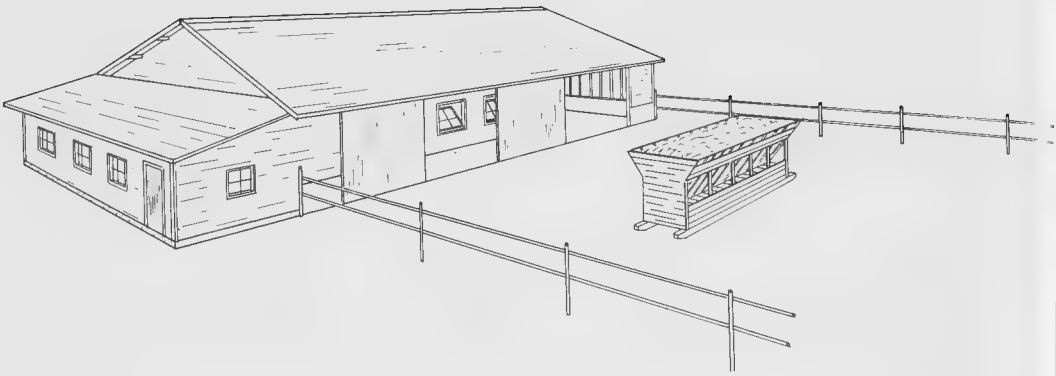


Figure 30.—Perspective view of gable-roofed loose-housing dairy barn with milking room on west side. Note outside feeder.

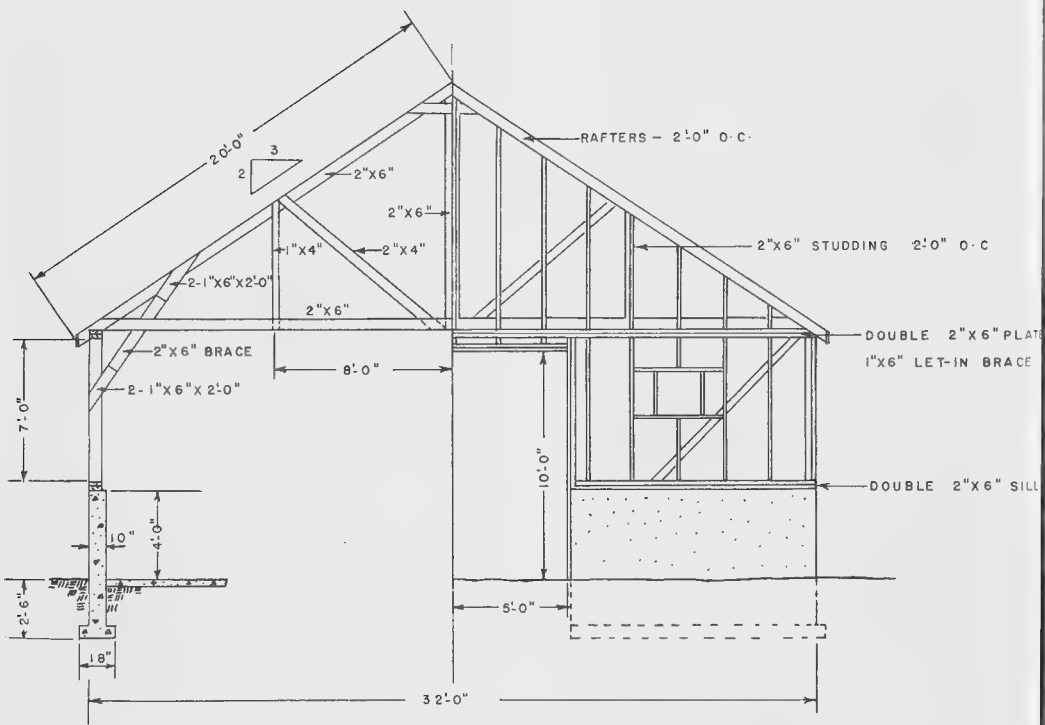


Figure 31.—Half section and half end framing of gable-roofed loose-housing barn.

Figure 32.—Old horse barn before remodeling.

Figure 33.—Above barn after being remodelled to modern loose-housing unit.

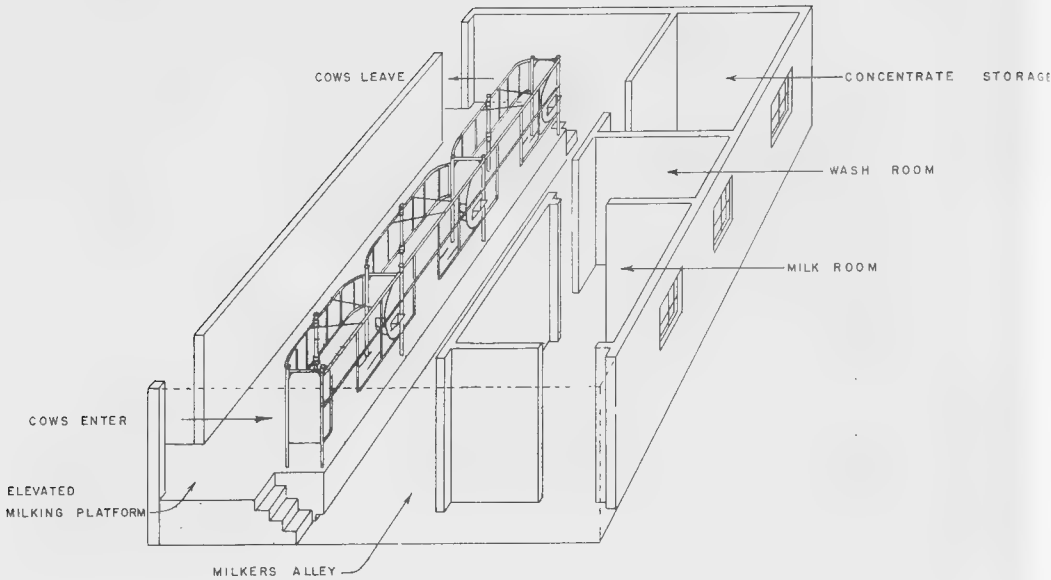


Figure 34.—Pictorial view of three stall milking room in milk area.

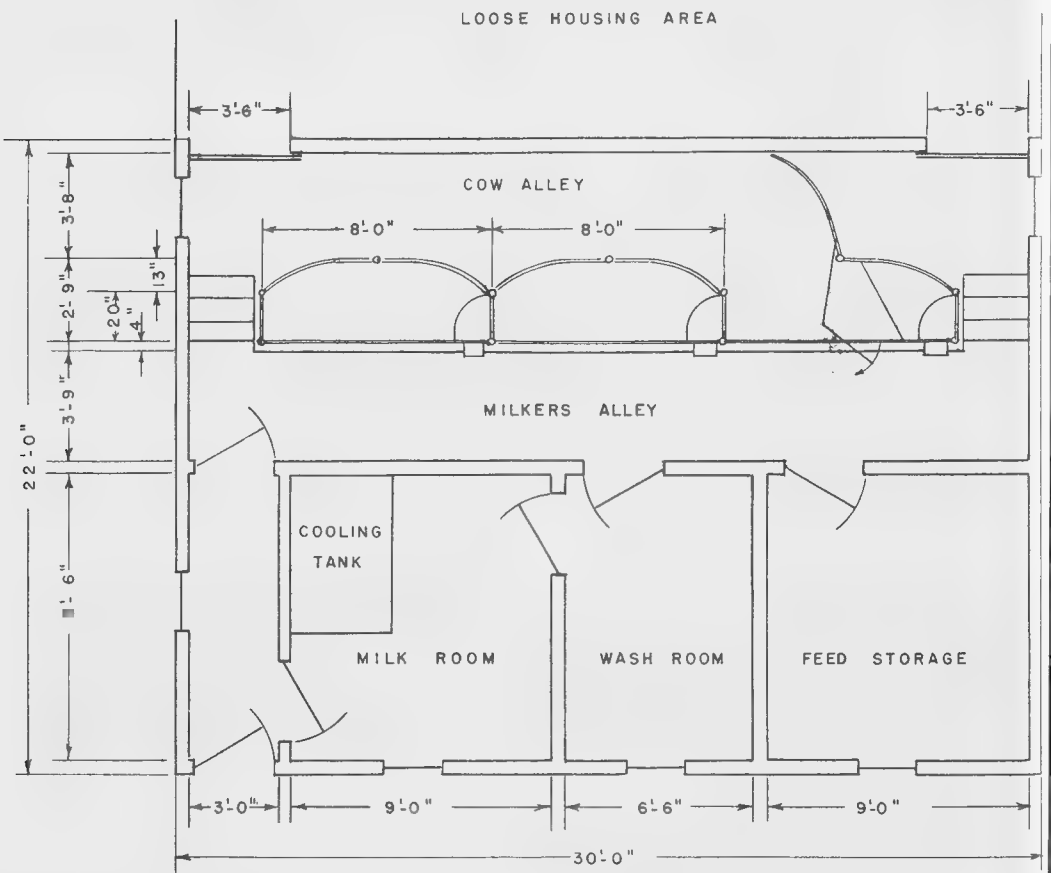


Figure 35.—Plan of milk area.

MILKING ROOMS

The milking room is the area in which the cows are washed, milked and fed their concentrate. The cows do not have to be driven into the milking room, but voluntarily line up and take their turns as the entrance doors are opened.

There are many possible stall arrangements for milking rooms. The simplest consists of one or more regular cow stanchions partitioned off from the loose housing area. The cows walk into the stanchions, usually at ground level, and back out after being milked and fed their concentrate.

A better and more common arrangement is the tandem, or in-line arrangement, with the stalls placed in line on an elevated platform. Figure 34 shows a milking room of this type with three elevated tandem in-line side-entering stalls, together with a milk handling room, wash room and concentrate storage room.

Each stall has two swinging gates forming one side of the stall. These gates are swung open by levers in the milker's alley to let the cows enter and leave the stalls. The front of each stall is closed in and contains a feed trough which is accessible from the milker's alley. Where overhead concentrate storage is possible, individual feed chutes to each stall can be arranged.

To save steps for the operator, the doors to and from the milking room are mounted on slanting overhead tracks. Ropes are brought from the doors to the milker's alley, so that the operator can pull the doors open. When he releases the ropes, the doors close automatically.

Elevated, in-line tandem, side entering, home-made stalls. Steel sleeves set in the concrete prevent decay of wooden posts.

Elevated, staggered tandem, side entering, commercial stalls.

Figure 35 shows a floor plan for a three-stall milking room in milk area. The dimensions shown for the stalls are for typical commercial stalls. These dimensions should be followed if you are building your own stalls out of wood or metal.

Make sure that the cow alley is wide enough so that the gates of the end stalls will not be partially obstructing the doors when the gates are opened. Match the number of stalls in the milking room to the size of herd.

Table 4, which is based on a maximum milking time of one hour and fifteen minutes, gives the number of stalls and number of milker units suitable for various numbers of cows. When considering the number of stalls, and a milking routine, remember that each cow must stay in her stall for 10 or 11 minutes. She needs this time to eat her concentrate.

TABLE IV

No. Stalls	No. Milker Units	No. Men	Cows per Hour	No. of Cows
2	1	1	12	Under 15
3	1	1	18	12 - 22
4	2	1	24	20 - 30
5	2	1 or 2	30	28 - 37
6	2	2	36	34 - 45

Since the milking room and milk-handling area must be kept warm, provision must be made for a heater and the walls and ceiling must be well insulated. The wall and ceiling sections shown in the section on stall barns (page 17) are suitable for milking rooms. It is particularly important to remember that a vapour barrier must be placed on the inside of the studding of this area. The humidity is high, particularly in the wash room, and the wall and ceiling insulation must be protected by a vapour barrier.

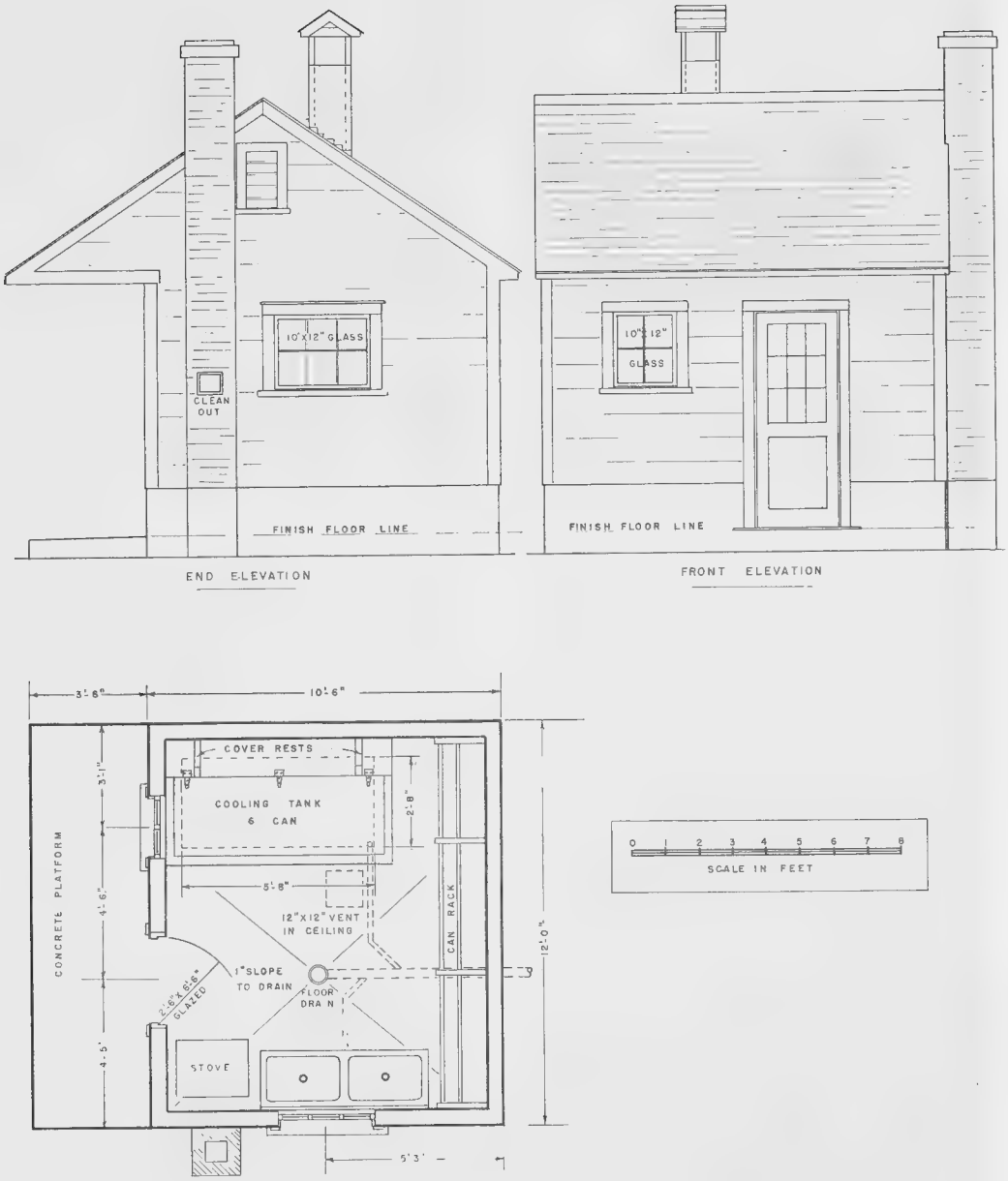


Figure 36.—Elevations and floor plan of a single-room milk-house.

MILK HOUSES

EVERY dairy farm should have a well-planned milk house. Milk in its many forms is one of the most important human foods. It deserves quality protection from the cow to the table. A suitable milk house and adequate equipment will make the job of quality control on the farm easier. Improved quality will guarantee markets and increase profits. The problem of the dairyman is to have a milk house that suits his needs and reduces labour.

Location

The milk house should be close to the barn. It is best attached directly to the barn, with a covered passageway between. Have the milk house on the clean side of the barn and provide good drainage.

For herds up to 20 cows a milk house at the end of the barn is usually satisfactory. For larger herds it should be at the centre to reduce the amount of walking.

Size

The size of the milk house will depend upon the amount of milk to be handled. It should not be smaller than 10 feet x 12 feet. Figure 36 shows a milk house of this size. For fluid milk producers, certain city health regulations require two-room milk houses. Provincial regulations state that if possible a two-room milk house should be provided. One room is to provide washing facilities, and the other is the milk room which holds the cooling tank. Figure 37 shows a typical two-room milk house. Consult your local health department on this point. The size will also depend on the equipment to be used. Wash vats, water heater, stove and separator will usually occupy the same space irrespective of the amount of milk handled. The variable equipment will be the pails, shipping cans, and racks for holding them.

Foundation

A good foundation is essential. It should be set fairly deep in the ground and carried six inches above floor level. Concrete is usually the best material. Soil type and condition will determine size of the footings.

Floors and Drains

Floors should be of concrete and trowelled smooth. They should slope to a central drain in the milk house at a slope of at least 1/4 inch to the foot. The floor should be rounded at the point where it joins the foundation so as to provide easy cleaning.

The floor drain is best in a central position, and the top of the floor drain should be set below the level of the floor.

Where a milk house is joined to the barn, the level of barn and milk house floors should be about the same. The passageway between the barn and the milk house should be 1 to 2 inches below the milk house and barn level. This will prevent water coming into the milk house and the barn, but a drain or outlet at the floor level of the passageway should be provided.

Walls and Ceiling

The walls should be made of material free of cracks that can be painted with a washable paint for easy cleaning. Some milk houses have been built of plywood. The ceiling will be constructed of the same material. Walls and ceiling should be insulated and a vapour barrier used on the inside of the insulation.

Heating the Milkhouse

Western conditions call for artificial heat during winter months, but more research is needed to decide the most practical method of heating. On the basis of cost only, the following is the order of available fuels — natural gas, coal, fuel oil, propane gas, and electricity. With expanding electric service in rural areas, various methods using electricity are becoming popular because of its cleanliness and convenience. Some of these include unit heater with a fan, heat lamps above wash vats, and hot-water radiators with circulating fans used in connection with the dairy heater.

In selecting the type of heating unit we have to consider the fire hazard, cleanliness, odours, cost of equipment, cost of operation, attention required and maintenance.

FRONT ELEVATION

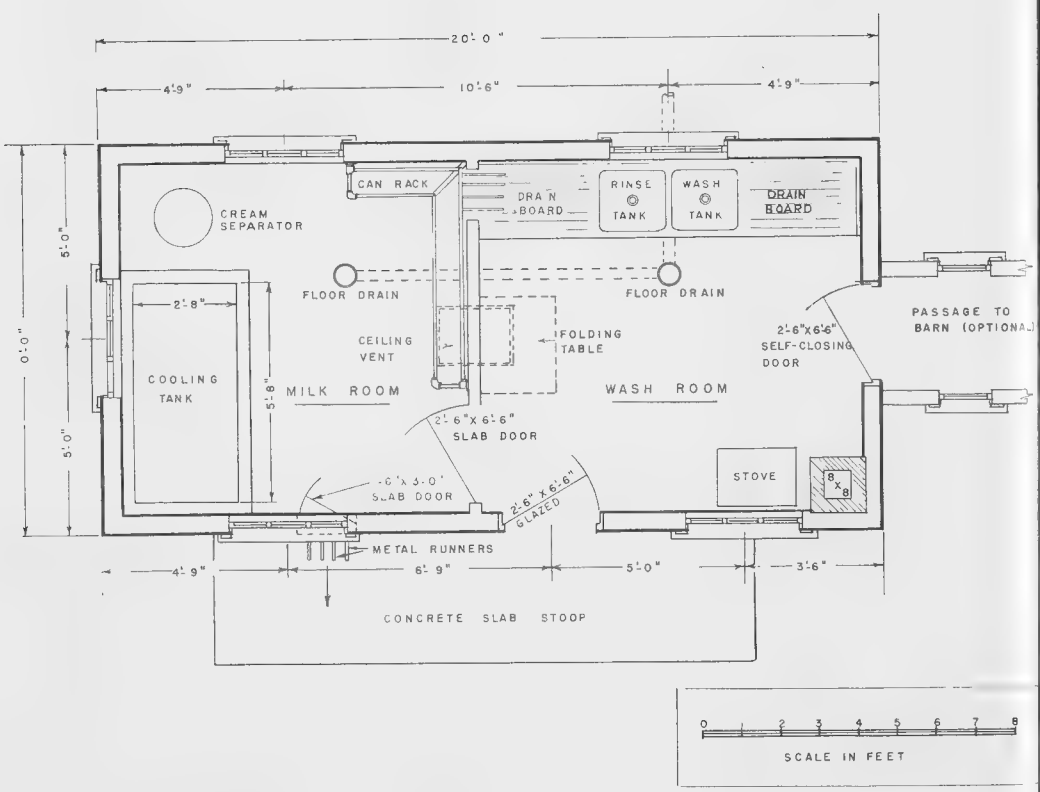


Figure 37.—Elevation and floor plan of a two-room milk-house.

Methods of Cooling

Production of high-quality milk and cream demands quick cooling to 50° F. or lower as soon as possible after milking. The method of cooling, and selection of a proper sized tank to meet individual needs, enter into the planning of all milkhouses. There are two main methods of cooling.

(1) **Water Cooling.**

Since most of the well water in the Prairie Provinces is below 50° F. it provides an excellent means of cooling. Where farm practice includes ice storage, its use for cooling water is highly recommended. A satisfactory method is to place the cooling tank between the well and the stock-watering tank, so that all water pumped for the livestock flows around the cans. The tank size is important, and a milk-water ratio of not less than 1:2 is recommended. That is, the tank capacity should provide at least twice as much cooling water as there is milk to be cooled.

(2) **Mechanical Cooling.**

With the increase in rural electrification many farmers are using mechanical units for cooling. The most popular is the immersion drop-in unit, which is readily installed in any well insulated concrete tank with insulated cover. The use of mechanical cooling reduces the amount of water needed and minimizes the overflow disposal problem.

Cleaning and Sterilizing

An ample supply of hot water is essential for cleaning all dairy utensils. Very often the water system will be connected with the space heater, giving an abundant supply when the heater is used. During the summer months an electric water heater is more satisfactory where power is available.

Sterilization of all dairy utensils is one of the most important activities in the milkhouse. It can be done by chemicals or by heat. Hot-air treatment of wet utensils in a cabinet heated by gas or electricity has proved very efficient.

The use of an electric water heater and a hot-air cabinet for sterilizing dairy utensils will have an influence on the floor plan adopted and should be considered before the building is started.

APPENDIX

CONCRETE WORK

We are indebted for the following to the Canada Cement Company, Montreal, to whom we extend our sincere appreciation.

TABLE 1 — SUGGESTED CONCRETE MIXES*

Use of Concrete	Imperial Gallons of Water Per Sack of Cement with Average Moist Sand	Sand and Gravel Per Sack of Cement		Largest Size of Gravel
		Sand Cubic Feet	Gravel Cubic Feet	
Most farm construction such as floors, steps, sidewalks, watertight basement walls, barnyard pavements, driveways, water storage tanks, cisterns, septic tanks, silos and grain bins.	4	2	3	1 in.
Foundation walls which need not be watertight. Thick footings, retaining walls and engine bases.	4½	2½	4	1½ in.
Very thin concrete sections such as fence posts, garden furniture and where concrete is about 2 inches thick.	3¾	2	2	¾ in.

*These are trial mixes for average conditions. *It is particularly important to use not more water per sack of cement than is shown in the table.* If the sand is very wet decrease the amount of water to be added by 1 gal. per sack of cement. If sand is dust dry increase amount of water to be added by ½ gallon per sack of cement and decrease quantity of sand used by 20%.

TABLE 2 — APPROXIMATE AMOUNTS OF MATERIALS REQUIRED PER CUBIC YARD OF CONCRETE*

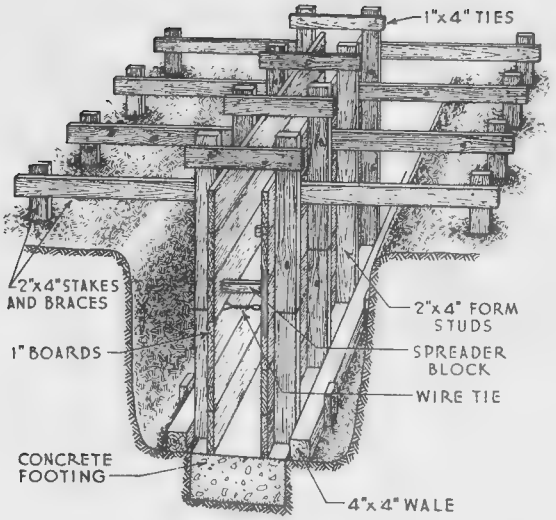
Use of Concrete	Sacks of Cement	Sand Cubic Ft.	Gravel Cubic Ft.	Largest Size of Gravel
Most farm construction such as floors, steps, walks, tanks, silos, etc. 1:2:3: mix	7	14	21	1 inch
Thick concrete sections such as footings, foundations and retaining walls. 1:2½:4 mix	5.5	14	22	1½ inch
Thin concrete sections, fence posts, garden furniture, etc. 1:2:2 mix	8	16	16	¾ inch

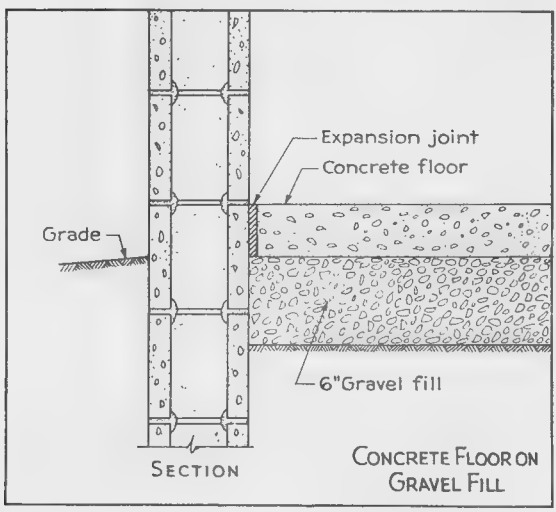
*Amounts of sand and gravel required should be increased about 5 to 10 per cent to allow for waste and variables.

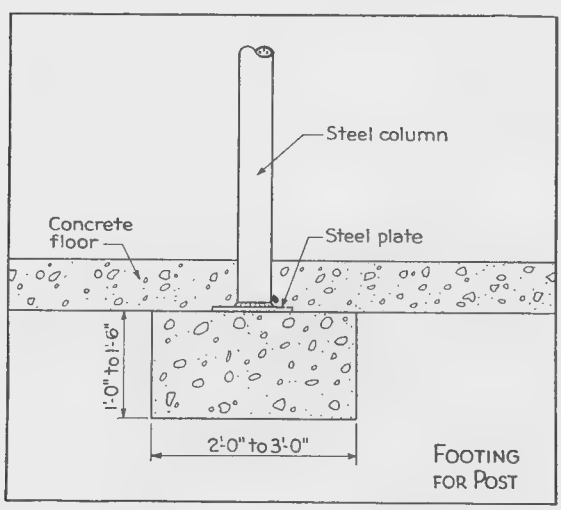
TABLE 3 — APPROXIMATE AMOUNTS OF MATERIALS REQUIRED PER 100 SQ. FT. OF 1:2:3 CONCRETE*

Thickness of Concrete In.	Concrete Cu. Yds.	Sacks of Cement	Sand Cubic Ft.	Gravel Cubic Ft.	Sand Cu. Yds.	Gravel Cu. Yds.
4	1¼	8¾	17½	26	⅔	1
6	1⅞	13	26	39½	1	1½
8	2½	17½	35	52	1⅓	2
10	3	21	42	63	1½	2½
12	3¾	26	52	79	2	3

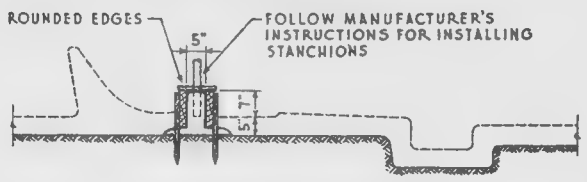
*Amounts of sand and gravel required should be increased about 5 to 10 per cent to allow for waste and variables.


1"x4" TIES
2"x4" STAKES AND BRACES
1" BOARDS
2"x4" FORM STUDS
SPREADER BLOCK
WIRE TIE
CONCRETE FOOTING
4"x4" WALE

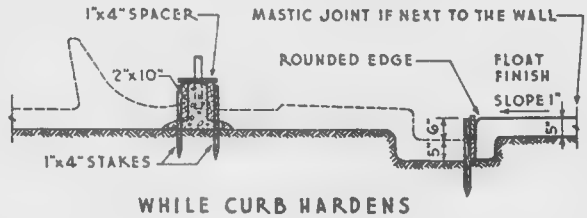

Expansion joint
Concrete floor
Grade
6"Gravel fill
SECTION
CONCRETE FLOOR ON GRAVEL FILL


Steel column
Concrete floor
Steel plate
1'-0" to 1'-6"
2'-0" to 3'-0"
FOOTING FOR POST

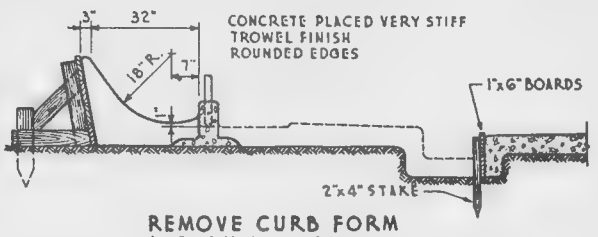
HOW TO BUILD THE FLOOR



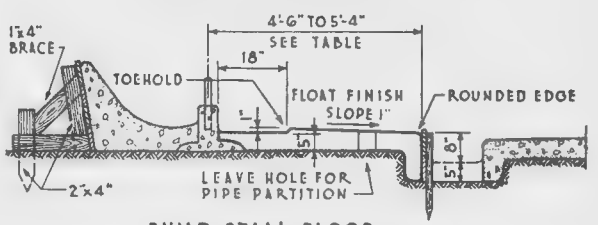
BUILD MANGER CURB FIRST



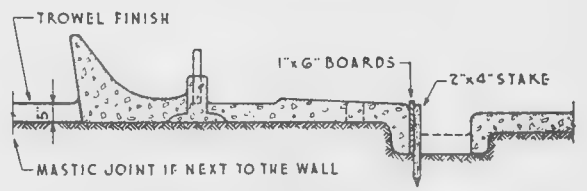
WHILE CURB HARDENS
BUILD LITTER ALLEY



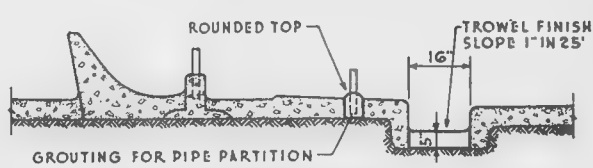
REMOVE CURB FORM
AND BUILD MANGER



BUILD STALL FLOOR
WHILE MANGER HARDENS



REMOVE MANGER FORMS
BUILD FEED ALLEY



PLACE GUTTER - GROUT
IN STALL PARTITIONS

NOTES

NOTES

DATE DUE SLIP

NOTES

FEB 01 1995
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DAIRY BARNS FOR ALBERTA/

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MacHardy, F. V.
Dairy barns for Alberta /

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